GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF CONTRACT ADMINISTRATION

RESEARCH PROJECT INITIATION

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Date: November 12, 1975

Project Title: Information Services on Research, Development and New Products in Textiles and Allied Fields

Project No: E-27-631

Principal Investigator: Dr. David R. Gentry

Sponsor: Whirlpool Corporation

Agreement Period: From 10/10/75 Until 10/9/76

Type Agreement: Agreement dtd. 10/10/75

Amount: $5,000

Reports Required: Monthly Progress Reports

Sponsor Contact Person (s):

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Whirlpool Corporation
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Benton Harbor, Michigan 49022

Assigned to: Textile Engineering

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SPONSORED PROJECT TERMINATION

Date: 4/12/78

ject Title: Information Services on Research Development and New Products in Textiles and Allied Fields

ject No: E-27-631

ject Director: Dr. Gentry

onsor: Whirlpool Corporation

fective Termination Date: 10/10/77

earance of Accounting Charges: 10/10/77

ant/Contract Closeout Actions Remaining:

X Final Invoice and Closing Documents

_ Final Fiscal Report

_ Final Report of Inventions

_ Govt. Property Inventory & Related Certificate

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CA—4 (3/76)

E-27-631

Information for Whirlpool
on
Research, Development, and New Products in Textiles
January, 1976

Prepared by:
The School of Textile Engineering
Georgia Institute of Technology

The Economy

The textile industry has been recovering from its recession for about ten months now. The low point in manufacturing activity was reached in February, 1975, with a Manufacturing Activity Index of 158 (1954 = 100 man-hours worked, adjusted for productivity changes). The November estimated index was 212.

With this recovery, prices of textiles have increased by more than 12 percent. Improving demand and increasing raw material prices have contributed largely to the price increases.

WHAT THIS MEANS FOR WHIRLPOOL: This increased activity will mean a greater rate of development of new products, some of which may not react the same as older products when "processed" by your appliances. Some of the problems may be imagined, but many may be real. Consumers buying replacement items may notice greater rates of appearance change on washing the new items than they have been accustomed to seeing on older items.

New Products

Burlington Industries is reported to have developed with Dow Corning a new process for treating bed sheets to resist bacteria and fungus growth.

Active bacteriostats and fungistats are applied topically in fabric finishing. The target markets for these products are hospitals and nursing homes. The treatment is said to be wash fast, to be safe to the skin, and to have the ability to reduce microorganisms, bacteria, algae, and yeast.

WHAT THIS MEANS FOR WHIRLPOOL: This product is typical of those arising from time-to-time. If the product performs as claimed, entry into domestic markets is possible. Claims of washfastness for any topical treatment should be viewed with some doubt.

Burlington is also reported ready to market a nonwoven fabric, "Nexus", for certain apparel applications. Nexus is not limited to any particular fiber and is different from most nonwovens in that it has a texture and appearance very similar to that of lace fabrics. The product is made by a patented process and represents a significant breakthrough in nonowoven manufacturing processes. It is currently being used in curtains and lingerie.

WHAT THIS MEANS FOR WHIRLPOOL: This product represents a new type of non-woven textile fabric that is suitable for non-disposable applications. It is now being used in washable products. Because of its nonwoven construction, appearance retention with refurbishing may be less than conventional woven or knitted construction. This means that washing severity will need to be less for these products. This breakthrough will trigger further development and make the use of nonwovens in non-disposable products more widespread.

Open-End Spun Fabrics

"Open-end spinning" is a term applied to a class of new yarn spinning processes that are steadily gaining in usage by textile manufacturers. These processes have much higher rates of production, but the yarn produced has characteristics different from conventional ring-spun yarn. Fibers in the

yarn are less parallel, are twisted less tightly, and fabrics made from the yarns have different surface characteristics. Manufacturers having both types of spinning systems are slowly learning that they cannot mix fabrics made from the two different yarns. The fabrics behave differently when subjected to acceptance tests by retailers. Presently, fabrics produced from open-end yarns include denims, t-shirts, and similar heavy fabrics.

WHAT THIS MEANS FOR WHIRLPOOL: It is likely that fabric surface defects - pills, fuzz, and frosting - will be more easily induced in these fabrics. More delicate treatment may be required.

Information for Whirlpool
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Flammability of Textiles

Flame Retardant Synthetic Fibers

Three typical approaches to flame retardancy are (1) topical FR application to fabrics, (2) manufacture of fabrics from "self-extinguishing" fibers, and (3) manufacture of fabrics from intrinsically flame retardant fibers. The latter group consists of fibers having flame retardants built-in or having very high melting points. Many short-comings still exist in this latter group, including high costs of fiber and processing, and limitations of properties such as pilling resistance, hand, and limited shades. There are approximately fifteen such fibers in various stages from experimental to commercial. No significant progress appears to have occurred over the past year.

WHAT THIS MEANS FOR WHIRLPOOL: Most products covered by state and Federal regulations will continue to be made flame retardant through topical applications for a long time to come. Your concern for cleaning without destruction of FR characteristics must continue indefinitely.

Federal Government Activities

NBS has recommended to CPSC a testing and classification scheme for the flammability of textile fabrics. The testing is for rate of heat transfer from a burning fabric using NBS's "Mushroom Tester" (so-called because of its

shape). Fabrics will be classified as

A - safest; max. of 0.1 cal/cm^2/sec.,

B - fabrics that do not ignite within 1 sec.,

C - fabrics that ignite in 1 sec. or less

Class A is expected to contain untreated nylon, wool, some acetates, and FR cellulosics. Class B would probably include polyester and polyester-cotton blends. Most current fabrics would fall into Class C. CPSC is expected to specify the class which certain consumer products must be made from.

WHAT THIS MEANS FOR WHIRLPOOL: CPSC's action will amount to specification of a degree of flame retardancy for many products, including shirts, blouses, trousers, dresses. Many fabrics used in these applications will not meet Class B requirements which such relatively loose-fitting garments are expected to fall. You will probably see FR additives applied but with less severe restrictions as currently exist for children's sleepwear.

Voluntary FR Efforts

Most standards-making and developmental activities to improve flame retardancy have resulted from government pressure. This pressure from CPSC seems to be abating presently. ASTM and AATCC activities are slowing down in response. Spokesmen for the industry have expressed the opinion that voluntary efforts have not gone forward because of the "legalese" involved in establishing liability and responsibility. They have proposed a no-fault liability insurance to establish the extent of liability to manufacturers.

WHAT THIS MEANS TO WHIRLPOOL: FR development activities are most likely to be geared to government pressure. Federal government pressure will be

similar to that reported above. Since Whirlpool interacts with consumers and textile products, has it thought of defenses against potential liability? What will be the effect of improved means of cleaning (e.g., agitation) on the permanance of FR treatments applied to fabrics?

Comfort Finishing of Synthetic Fabrics

The hydrophobic nature of most man-made fibers is considered to be one of the major comfort problems in garments made from man-made fibers. There have been recent attempts to modify hydrophobic fibers to impart a hydrophylic character. The approaches include topical finishing, radiation techniques monomer grating, and surface etching. Results have been reasonably successful and indicate the feasibility of a new type of product: a garment being essentially hydrophobic in nature but having hydrophylic characteristics at the surface. Such garments would be more easily dried than their hydrophylic counterparts. Although not yet confirmed, it is distinctly possible that problems of soil redeposition on hydrophobic products can be improved.

WHAT THIS MEANS FOR WHIRLPOOL: Possible replacement of items, made principally from rayon and cotton with polyester, nylon. Energy saving in drying by the consumer. A need for Whirlpool's equipment to clean such products adequately without destroying the surface treatment.

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Bacteria Resistant Textiles

We commented in January about Burlington's proposed bacteria resistant bed sheets. Burlington is now marketing in test markets their Bio-Guard socks, treated with bacteriostats and fungistats. A favorable reception is reported by customers through retailers who report satisfaction and positive feedback from customers. Foot problems are not completely stopped but are reported to be controlled.

WHAT THIS MEANS FOR WHIRLPOOL: Acceptance of such products may be only temporary; it is too soon to say. If such products do become a trend, it means an additional factor interacting in the textile product-cleaning system. Appliances must clean adequately but must not remove the active bacteriostats and fungistats.

Cotton Fiber Production, Consumption

The National Agricultural Outlook Conference reports that world production of cotton is expected to fall by 8 percent in 1975-76. Producers in this country are optimistic about the prospects of an upturn in foreign demand for U.S. cotton. Consumption of cotton textiles did decrease significantly during the recent recession, and producers are expecting increases this year, both domestically and world-wide.

WHAT THIS MEANS FOR WHIRLPOOL: Cotton is still far from disappearing. In fact, the rate of decrease of cotton consumption relative to other fibers has slowed significantly.

Care Labelling

The Commerce Department recently published proposed revisions to care labelling requirements. The revisions require more explicit instructions than were made available previously and extend responsibility for developing care procedures to fabric manufacturers and producers of other intermediate products.

WHAT THIS MEANS FOR WHIRLPOOL: Apparent short-comings of the previous requirements prompted this move. The requirement that fabric manufacturers supply care instructions to their customers may often result in misleading information The net effect of this move in accomplishing improved care instructions is questionable.

Non-Wovens

At a recent meeting of the International Nonwovens and Disposable Association, the idea of nonwovens in apparel was voiced from several sources. Manufacturers predict that fabrics suitable for children's outer wear will be available within three to five years and for adult outer wear within ten years. Children's wear offers an easier target because of its shorter life and less critical aesthetic demands. Even so, manufacturers recognize that children's wear must withstand extensive washing - up to 100 times.

WHAT THIS MEANS FOR WHIRLPOOL: The nonwovens manufacturers have not given up their efforts, and as mentioned previously, products of this type will become more prominent and will offer their own unique contributions to problems of refurbishing.

Carpets

January carpet markets revealed a growing trend in the "soft hand" styles of carpets. This soft hand is obtained with the use of six, eight, or ten denier per filament fibers, compared to the conventional carpet fibers of twelve and fifteen denier. Additional trends were to cut pile, heat set yarns, and to multicolor print styles.

WHAT THIS MEANS FOR WHIRLPOOL: The trend toward softer, fine yarn carpets is a trend away from durability. Most such carpets are of higher "quality" but in the sense of styling as opposed to performance. Additional challenges in appearance maintenance may be in the offing because of the predominance of such styles.

Information for Whirlpool
on
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Polyester Flammability

We know that some of you are aware of the recent charges that tris 2-3 dibromopropyphospate, a compound used to treat polyester fabrics to improve flame retardance, might cause cancer. This information was made public in the news press and was based on information developed by a researcher at Cornell. This compound is used on 100 percent polyester fabrics going into children's sleepwear and is apparently not used on blends of polyester with other fibers.

Reports from retailers indicate little noticeable reaction by consumers. Retailers themselves are reported not to be concerned by the unproven charges and have no plans to reduce or eliminate future orders of children's sleepwear treated with the compound. Estimates place the volume of children's sleepwear made of 100 percent polyester at 50 - 65 percent of the total.

This scare may provide additional impetus to work by the major polyester producers who are attempting to develop flame retardant polyesters. Their work reportedly involves the incorporation of bromine or phosphorous containing copolymers into these flame retardant polyesters. A consortium project, sponsored by the Consumer Product Safety Commission and directed by researchers at Clemson University, has been actively working on the polyester/cotton flammability problem for over a year. They are reported to be exploring the curing of vinyl-type monomers on polyesters by electron beams.

It is also reported that a significant proportion of polyester carpets are treated for flame retardancy using tris. If indeed the product is shown to be carcinogenic, substantial economic blows will be felt in the home furnishings area.

WHAT THIS MEANS FOR WHIRLPOOL: Manufacturers will be watching CPSC's investigation of this product closely. In the meantime, fiber manufacturers may well introduce polyesters improved for flame retardance, although these may not be totally satisfactory. In the event the government bans this product, there will be a significant reduction in children's sleepwear containing polyester.

Advanced Technology Applications in Garment Processing

New, direct, automatic, fast, and inexpensive methods are being developed for converting polymer chips and/or staple fiber into fabrics without carding, spinning, and weaving or knitting and garments without cutting and sewing in

work sponsored by NSF at Georgia Tech. Other objectives are to reduce material, labor, capital, and energy costs in textile and garment manufacture. The successful development of one or more of these processes will contribute to improving the U.S. competitive position in textiles and clothing in world markets.

To date, work has been done on processing polypropylene into blown film. This approach appears to hold promise for the production of fabric and garments directly from polymer. Improvement of fibrillated web strength, weight, and opacity suitable for most garment applications is currently being investigated.

WHAT THIS MEANS FOR WHIRLPOOL: Although this work is fundamental, it represents an approach which again indicates a future direction. Many garments currently made from woven or knitted fabrics will in a few years be made from nonwoven fabrics. Economics of production will dictate this change and will provide the needed impetus for the development work needed for adequate nonwovens.

Burlington Socks

This topic continues to return. We commented previously about Burlington's BioGuard socks treated with a fungistat to control foot diseases. The government has now stepped in and ordered Burlington to stop shipping and selling these products. EPA is concerned that the products will leach out in quantities that may be harmful to individuals.

WHAT THIS MEANS FOR WHIRLPOOL: You won't have to worry about products like this for a while.

Information for Whirlpool
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May, 1976

Nonwoven Technology

Additional research studies were recently published providing quantitative information relating fiber properties to nonwoven fabric properties. Cross-sectional shape of fiber will affect fabric stiffness and fabric aesthetics. Higher fiber-binder interaction is obtained with increased surface area of the bond. A new star-shaped polyester fiber having a surface area 49% greater than circular fibers of the same strength produces fabrics with similar strength increases. Hollow fibers which can buckle have been shown to produce fabrics having notably different appearance and unusual absorbency potential. The use of crimped fibers instead of uncrimped fibers has been shown to produce fabrics having properties relatable to crimping of fibers.

WHAT THIS MEANS FOR WHIRLPOOL: There is a steady, notable amount of research relating to increased understanding of fiber - process - fabric relationships in nonwoven fabrics. This is the kind of effort needed to achieve that breakthrough in the development of fabrics suitable for woven and knitted fabric applications. This breakthrough will come because of the tremendous economic advantage of nonwovens.

New Market for Nylon Knits

Tricot fabric knitters are attempting to develop a new market for their products, this one being specifically bedsheets made from antistatic nylon multifilament yarn. The demand for such a product is unknown as yet and results from very poor market conditions in the printed tricot fabric business.

WHAT THIS MEANS FOR WHIRLPOOL: Knitted bedsheets offer possibilities for fitted lower sheets; however, it seems to us that knitted upper sheets would not provide satisfactory stability. This effort will bear watching, however.

Applique - Printed Products

FabricsAmerica Corporation of Atlanta has developed a printing system that produces fabrics resembling applique.
These fabrics reportedly resemble flocked fabrics in texture, jacquard fabrics in appearance, and fine embroidery. The method involves the use of an expandable foam, based on an acrylic polymer, polystyrene, and a blowing agent. The blowing agent expands the printed and dried design with the application of heat. The prints are applied to cotton, cotton/polyester, and polyester fabric, thus creating a fabric resembling an expensive woven fabric from relatively inexpensive print fabrics. The applique fabrics are claimed to be resistant to washing.

WHAT THIS MEANS FOR WHIRLPOOL: This product represents a low-cost, fancy fabric which may find its way into applications requiring frequent cleaning. It would seem that appearance retention at best would be marginal and if so would mean that such products would not gain any real acceptance. It does serve to illustrate again the wide variety of easy-care products challenging your industry.

Polyester Carpets

Polyester carpet yarns are becoming of greater interest because of the styling trend toward the use of shag carpets with very high pile yarn weights. Such yarns must be heat-set for good pattern definition and polyester lends itself to this set of conditions. The use of polyester in the carpet industry seems governed by its low cost compared to nylon. Polyester has good performance characteristics which compare to those of nylon with one exception, that of sufficiently good pattern definition retention.

WHAT THIS MEANS FOR WHIRLPOOL: Polyester carpets have not performed satisfactorily for consumers in most styles. If carpet manufacturers move more and more to polyester in heavy weight carpets because of low costs, this lack of appearance retention may well become a greater problem. Often, consumers expect refurbishing procedures to work miracles, and the greater use of a marginally-performing yarn in more costly carpets could mean problems.

Carpet Shipments

Shipments of carpets in 1975 totaled over 837 million square yards, about 100 million less than that shipped in 1974. Nylon face yarns totaled 234.6 million pounds, representing about 70 percent of the face yarns used in carpets.

WHAT THIS MEANS FOR WHIRLPOOL: Carpets are principally made from nylon, and the percentage made from nylon has grown in recent years.

Abrasion of Durable Press Fabrics

Improvement of edge abrasion resistance of durable press garments is the objective of a patent by Cotton, Incorporated. The patent covers a procedure for applying a protective barrier selectively to the surface of a portion of garments that is susceptible to edge wear. This barrier prevents contact of at least one of the catalyst-forming components before exposing the garment to formaldehyde and heat curing. The edges are therefore less substantially crosslinked, while the main portion of the garment is crosslinked as usual.

WHAT THIS MEANS FOR WHIRLPOOL: This procedure will result in less wear at cuffs and folds in garments and perhaps alleviate one of the difficulties in wash and wear products.

New High Wet Modulus Rayon

FMC Corporation has developed a crimped version of their high wet modulus rayon which reportedly retains the desirable properties of high wet modulus rayon while providing increased covering power in fabrics. The product has been used to produce wool-like fabrics which are washable.

WHAT THIS MEANS FOR WHIRLPOOL: Many of the developments being introduced have as their objective the manufacture of products having characteristics making care and refurbishment much simpler. This produce is another item fitting into this category.

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Flame-Retardant Cotton Work Clothing

Cotton, Inc. indicates that a 9.7 million-pound potential exists in FR cottons going into work clothing for metal workers. They similarly predict a potential 3.5 million-pound potential for cotton in the market for fire fighters. Over 1 million pounds are predicted for each category of automotive, chemical, and petroleum areas. It is expected that these areas could become subject to enforced regulations by 1980. (WDF)
WHAT THIS MEANS FOR WHIRLPOOL: Refurbishment of clothing having an additional necessary property which must last.

Market for FR Children's Wear

Sears, Roebuck states that flame-retardant children's outerwear apparel has become one of the biggest disappointments in recent sales history of Sears catalogues. Part of the reason for lack of interest is the fact that such apparel must presently be made from 100% polyester or 100% cotton fabrics. This limitation imposes a severe limit on choices. Sears sold two boy's shirts on the same page of the catalogue last year. One was FR woven polyester priced at $3.99, while the other was regular polyester/cotton in the same style at $3.49. The non-FR shirt sold four times the volume of the FR shirt. Regular jeans sold 200 times as many as FR jeans. (DRG)

WHAT THIS MEANS FOR WHIRLPOOL: Such news should not be taken as an indication that FR apparel will not become a staple item. Technology on FR polyester/cotton fabrics is moving forward.

Spun Yarns in Double Knits

The concensus of papers delivered at the National Knitted Outerwear Association convention was that spun yarns are the only way to save double-knits. The double-knit market grew immensely with textured polyester yarns and the failure of these fabrics to perform satisfactorily resulted in losses among now defunct knitting companies of $150 million over the past 20 months. Proposed new fabrics would be made from polyester/cotton blended yarns and possibly combinations of spun and filament yarns. Production of such fabrics will cost more because of higher yarn manufacturing, knitting and finishing costs and increased amount of second quality fabric. (DRG)

WHAT THIS MEANS FOR WHIRLPOOL: Polyester double-knits made up a significant portion of the outerwear market. Products such as the above may replace some of the now-lost markets. Care procedures for such products will not be identical to previous double-knits and may require some attention.

Fabric Printing Processes

ATMI reports that about one-fourth of the broadwoven fabrics made in the U.S. in 1974 was ultimately printed. This increase was attributable to developments in rotary screen printing processes. Heat transfer printing has also begun to increase the quantity of fabrics colored by printing methods. (WDF)

WHAT THIS MEANS FOR WHIRLPOOL: Printing usually means multi-colors and bright fabrics. Such fabrics present added challenges and opportunity for

increased problems in cleaning. Prints are also related to fashion; popularity may decrease, increase from time-to-time.

Seamless Jackets

The Wool Industry Research Association of Britain reports a three-year project directed at developing a molding process to eliminate the need for back and side seams in men's jackets. Included in the project's scope are means of dyeing and finishing the new products. A process of this type will lead to a 30 percent savings in the cost of producing coats and jackets. (WDF)

WHAT THIS MEANS FOR WHIRLPOOL: Although this product is not washable, this development work points toward a recognized need for producing apparel wear with streamlined processes. We have cited such efforts previously.

Denim Production from Open-End Yarns

Studies show that physical standards for heavy weight denim can be met with careful selection of raw cotton processed into open-end yarns. Improvement in strength and stiffness of fabrics can be obtained by increasing the numbers of yarns per square inch over the number normally used. Open-end spun yarns are approximately 20-30% weaker than normal spun yarns and are different in other characteristics. (DRG)

WHAT THIS MEANS FOR WHIRLPOOL: An illustration of conversations held with some of you about this new yarn spinning process.

Carpet Cleaning

The Carpet Cleaners Association in Britain is initiating a two-year program designed to develop objective tests for measuring degree of soiling

and to compare the effectiveness of commercial cleaning procedures. Participants include carpet producers, equipment manufacturers, and cleaning-agent manufacturers. (DRG)

WHAT THIS MEANS FOR WHIRLPOOL: Methods for measuring effectiveness of carpet cleaning methods are much less well-defined than are methods for measuring effectiveness of cleaning of fabrics. Results of this work will be of much interest in this country.

Polyester/Cotton Flammability Study

A two-year study sponsored by the Commerce Department having the objective of developing commercial flame retardants for polyester/cotton blends is coming to an end. The study has been conducted by a consortium of nine organizations and has investigated the problem from several approaches, including incorporation of flame retardants into polyester, radiation grafting of flame retardants as an alternative to chemical fixation, and the use of silicone compounds for restoring softness after flame retardant treatments. Although results are not available, the project directors are optimistic that they will have been successful in producing a commercial system for imparting a sufficient degree of flame retardance to polyester/cotton blends. (DRG)

WHAT THIS MEANS FOR WHIRLPOOL: This problem is the most significant one for flame retarding of textiles. Its solution may have a bearing on acceptance of FR apparel by consumers.

Behavioral Studies of Carpet Purchasing

Studies relating to buyer motivation in purchases of carpet have been made in England. Results were obtained through observation of potential purchasers rather than by the usual questionaire approach. It

was found that carpet purchases are centered on the point of sale and that retail support is the most critical factor. Manufacturers are advised that they could benefit significantly from becoming involved in the training of retail salesmen. Carpets cannot be sold without the customer coming into contact with the carpet. At that point, the retail salesman is the most important factor in influencing the customer's decision.

WHAT THIS MEANS FOR WHIRLPOOL: Carpet retail salesmen in this country are generally not knowledgeable about carpets and the unique characteristics of various carpet styles and fiber types. They are without doubt much less knowledgeable about carpet care and maintenance.

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Highlights of ATMI Annual Meeting

The American Textile Manufacturers Institute (ATMI) is the textile industry trade association. Their 27th annual meeting was held in San Francisco in the Spring. Comments made at the meeting by industry leaders provide an insight into problems and opportunities the industry faces.

The outgoing president, John M. Hamrick, summarized accomplishments and problems. The industry's early recovery from the recession caused government leadership to take a renewed interest and attach more importance to the industry. At present, 12 percent of the work force is employed in the fiber-textile-apparel industry, producing shipments valued at $39 billion. As a result of the recession and the energy crisis, production is almost as high as pre-recession levels with six percent more output per man-hour and six percent less power consumption than in 1973. Major problems from a business standpoint appear to be imports, particularly the threat from China, and funding for capital improvements.

Based on recent rates of growth in dollar sales, 7 percent per year, industry leaders foresee financing needs of $13 billion by 1980. Most of this can be financed by depreciation allowances and profits; however, these sources can cover only 70 percent of anticipated needs. Horace Jones of Burlington Industries states that an increased capital program will require higher

profit margins and enlightened tax policy in regard to investment credit, depreciation, and dividends. He foresees a tough competitve fight ahead to obtain the capital needed.

Joe Lanier of WestPoint Pepperell sees four dominant factors affecting capital needs. These include shortages and increasing costs of labor; technical innovations by machinery manufacturers and synthetic fiber producers; compliance with government regulations; and the availability of capital. Of these, compliance with government regulations offers the greatest challenge. The industry is presently not generating sufficient profits to pay dividends, modernize, and spend money meeting OSHA and EPA requirements. It has been estimated that the industry will need $785 million to meet 1983 water pollution standards, $890 to meet cotton dust standards and $1 billion 87 million to meet noise standards.

Overall, it appears that textile industry management foresees minimal change in the next several years with regard to new technology of production and new products. At present, the greatest emphasis is on developing information useful to the government in setting pollution and noise standards, and later will turn to equipping mills to meet these standards.

Trends in Carpets

The recent June carpet market in Chicago was not a great success in terms of sales. However, this market is traditionally weak, and the recent event becomes part of a continuing trend which may ultimately cause producers to eliminate the June market.

There were a number of new products shown. Softer colors and softer hand continue to grow in importance. The softer hand is being achieved primarily through the use of finer fibers and filaments. Hopefully, the fiber producers have evaluated the performance of these products because conditions producing softer hand also bring about reduced performance level and increased problems in care and maintenance. Print carpets continued to grow in prominence, being described as "color applications" instead of traditional prints. These carpets are produced by such proprietary processes as Deering Milliken's Millitron system and Cabin Craft's Dynapoint system. Both permit production of multi-colored, large-pattern, freestyle prints.

Technical developments involved principally the printed products that were exhibited. An increased number of "bonded" carpets were introduced, manufacturered by a principle in which fiber batts or yarns are bonded to a backing substrate. The processes offer production cost advantages, and all are proprietary processes. Carpets produced have similar appearance and properties to that of tufted carpets.

Polyester yarn and fiber usage increased, with principal increases seen in Eastman's Kodel V, a carrier-free dyeing fiber. No new developments in anti-soiling or anti-static fibers were apparent.

Solvent dyeing of carpets is a basic processing change that is developing. Some samples of solvent-dyed carpets, dyed with proprietary systems, are appearing on the market. This development has greater internal implications for the carpet manufacturer than it does for consumers. DRG.

Nonwoven Fabric Development

The Textile Research Institute in Princeton, New Jersey, has reported that a crepe-like structure imparted to nonwoven fabrics opens up increased potential for usefulness. Nonwoven polyester crepe fabrics have been prepared in the laboratory and have been creped using a stuffer box technique. It is reported that slight changes in the fabric geometry by creping result in fairly large changes in fabric drapability. The drape of these fabrics is reported to compare favorably with that of woven fabrics of equal weight. Stretchiness can readily be adjusted to levels characteristic of that of woven fabrics. These fabrics have also been evaluated as filter fabrics. Filtration efficiency is improved, air resistance is lower than that for uncreped fabrics, and dust holding capacity is increased. (TRI News and Research Briefs - Spring 1976). DRG.

Ultrasonic Sewing of Non-Thermoplastic Fabrics

A development has been reported which makes possible ultrasonic bonding at seams of structures made from non-thermoplastic fabrics. The Reece Corporation, Waltham, Mass., and General Fabric Fusing Co., Cincinnati, Ohio have developed an adhesive facing to be used to adhere non-thermoplastic fabrics by use of equipment such as Reece's Insta-Sonic Machines. The facing adhered to the fabrics is thermoplastic and capable of bonding.

Although there may be unseen advantages to this route, a question arises - why bond adhesively to enable thermoplastic bonding? Why not bond with an adhesive and be done with it? The work does represent on-going efforts to develop means of fabrication which are less expensive and faster than methods currently existing. (Daily News Record - July 19). DRG.

1977 Fashions

Mills are reported to be reducing product lines for 1977 with the aim of better utilization of equipment and lower fabric costs. The emphasis appears to be on fabrics with a natural look and hand achieved through yarns, colors, weaving and knitting techniques, and finishing. Lighter weights and softer hands will also be popular. A reedy appearance and shadow striping is reported to be in store for fabrics intended for shirtings, children's wear, and women's dresses. The denim appearance will spread to knitted ribs, singleknits, and doubleknits, all made from spun polyester and cotton with textured polyester. (Textile World - March) DRG.

Carbon Fibers

Union Carbide recently disclosed two advances in carbon fiber technology which should lower costs and expand their uses in structural applications. One of the developments is a method of making carbon fibers from petroleum pitch. The process produces fibers less expensively than methods previously used. Another development is a procedure by which carbon yarns can be woven into fabric. By making composites from fabric instead of unidirectional fiber tapes, a fabricator can impart strength and stiffness in the direction he wants. The weaving problem was solved by carbonizing the fabric after it was woven. (Textile World - March) DRG.

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Trends in Nonwovens

The pace of activity in nonwoven product development has increased in the past year. The result has been a few major developments - we have commented on most of these in previous months -, but for the most part, activity has been change in fibers, binders, and processes. Rayon has been the primary fiber used because most nonwovens have been used principally in absorbent disposable products; however, other fibers are coming into use because of a shifting market share from disposable to durable nonwovens.

Projected markets for nonwovens in the six largest product areas are as follows:

Diapers	$175 million
Carpet backings	$140 million
Coated, laminated fabrics	$130 million
Interlinings, facings	$130 million
Filters	$120 million
Bedding, accessories	$115 million

Note that all categories except diapers are durable products. Interlinings and interfacings in apparel are moving increasingly to nonwovens. In carpets, nonwovens are replacing jute at an increasing rate because of the price and supply problems of jute fabrics.

Increased growth of nonwovens in filtration applications is anticipated because of a better cost-filtration performance than the traditional materials in some applications. In this regard, textiles in filtration applications will be the subject of a two-day symposium of the Fiber Society at Princeton, N.J., on November 9 and 10. Whirlpool personnel desiring additional information on topics and speakers can contact us for this information. The meeting will be open to persons who are not members of the Fiber Society.

Most nonwovens are made by forming a fibrous web and then bonding the fibers with chemical binders. In most instances, the binder overwhelms the fibrous web, causing the finished fabric properties to be governed principally by the properties of the binder. Much of the development activity is going on in this area with the purpose of producing nonwovens with appropriate tensile and stiffness characteristics. Binding with low melt polymers or fibers and with soluble "binder fibers" which when dissolved and solidified join non-soluble fibers forming the base fabric are also being investigated.

A significant development in forming fabrics without binders is the spun-laced process developed by DuPont, which we have mentioned

earlier. This fabric resembles textile fabrics manufactured by conventional means and is finding its way into many markets. A second process recently reported manufactures an all-cellulose nonwoven without a binder. Developed by the Mitsubishi Rayon Company, this process uses a fiber having three components - hydroxymethyl cellulose xanthate, cellulose, and sodium cellulose xanthate - arranged in concentric layers. The hydroxymethyl cellulose xanthate contributes the adhesion characteristics when the fabric web is passed between heated rolls, and also causes shrinkage which imparts a bulkiness to the fabric. Little has been published regarding the properties of fabrics made with this product, although end products mentioned include many disposable and durable products.

Machine Washable Wool

A process developed by the Commonwealth Scientific and Industrial Research Organization in Australia is reported to be beneficial in giving wool fabrics resistance to shrinking in washing. The process is named Sirolan BAP and consists of a two-component resin formulation in an aqueous medium. The new process is said to impart improved abrasion resistance, smooth drying, anti-snag, anti-pill, and anti-curl properties. The process is claimed to be the first commercially proven aqueous process for the shrink resist finishing of knitted or woven worsted wool fabrics.

Products of this type seldom achieve striking commercial acceptance. If this development appears to be significant, we will comment further as it is tried in the industry.
(Textile Month, July, 1976)

Capital Investment in Textiles

Werner Textile Consultants estimates that world fiber consumption will increase 80 percent in the next 15 years. The major portion of this increase (73 percent) will develop from increases in per capita consumption, while only 27 percent will come from population increases. While substantial growth is assured, Werner predicts that many individual producers and, in some cases, some individual countries will fall by the wayside in textile production. The causes for failure will be bad or poorly timed capital investments.

Manufacturers will need to consider the relationship of investments to profitability because of the ever-increasing reduction in profit levels. More than in the past, Werner indicates that capital investment decisions must be made on a scientific basis. Similarly, manufacturers must maintain an awareness of technological advances and must consider what it will cost not to replace machinery with technologically improved equipment. The most difficult issue to deal with in making investment decisions will be that of inflation, since most businessmen have not been accustomed to considering this factor in long-term business decisions.

On the whole, Werner implies that these decisions are now more difficult and more critical than has ever been the case in the textile industry. Most textile manufacturers are aware of the difficulties facing them because of increased non-productive investments required to meet EPA, OSHA, and CPSC standards.

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ATME - International 1976

The American Textile Machinery Association will sponsor its biennial textile machinery exhibition at Greenville, S.C. from October 25 - 29. This year's exhibition also includes machinery manufactured by foreign firms. Over 25,000 visitors are expected to attend the exhibition which includes more than 375 exhibitors from 22 countries.

Many of the machinery developments to be displayed are reported to be related to challenges imposed by governmental regulations in abatement of air and water pollution and noise. Energy requirement has been of concern in the development or modification of equipment. Many manufacturers are reported to have been less open with information about machinery to be exhibited. It is doubtful that this secrecy means significant breakthroughs in machinery development because this exhibition is so close to last year's international exhibition in Milan.

Mills are reported ready to buy; however, they are spending with great care considering the investments projected for meeting government regulations.

Progress Report on Flammability

Government officials report that there may not be an answer to the question regarding the flame retardant tris 2 - 3 dibromopropyphosphate as a cancer-causing chemical until mid-1977. The National Cancer Institute states that life-time study on the effects of Tris will not be finished until next September. It is reported that manufacturers are continuing

to buy fabrics treated with this compound for apparel under mandatory regulations, but not for the voluntary market.

Business Communications Co. has issued a report on Flame Retardancy of Textiles, stating that by 1980, 36 percent of the market areas will have some flame retardant textiles. Carpets and rugs will remain the largest end use for flame retardants. Annual consumption of FR chemicals will be on the order of 230 million pounds in 1980.

Dollars spent on flame retardant textiles are reported as follows:

	FR Finishes	Inherent FR Fibers
1969	10.75	300.0
1973	25.8	422.0
1975	28.1	361.0
1980*	100.7	663.9
Average Annual Growth	21.5%	6.7%

*Estimated

All amounts are millions of dollars.

It is observed generally that flammability of textiles is receiving more attention in Europe than in the U.S. The Japanese have exceeded Americans in research activities in the area of clothing ignition, burn injury, and plastics flammability.

New Silicone Water Proofing System

The Ciba-Geigy company reports the development of a new silicone water proofing system based on their Photobone SP and BC products. The system is claimed to give improved water repellancy along with improved fastness to washing and drycleaning, and a soft fabric feel. This system is intended for polyester-cotton rainwear but is said to be applicable to other fibers and fiber combinations. Resins which are to be crosslinked can also be applied with the Photobone finish imparting wrinkle resistance to fabrics that otherwise require pressing after cleaning. The principal claim of the water-proofing system is that of improved water resistance with improved fabric feel.

Humidity Control in Drying

Several improved humidity measuring techniques based on semi-conduction technology have been reported recently. It is intimated that substantial benefits can be gained from these techniques through the application of such techniques to the drying of textiles. These benefits include higher product quality through optimal drying levels and improved uniformity of drying in manufacturing operations involving drying. Production processes can be made more efficient with resulting higher production amounts and significant reduction in heating costs by eliminating over-drying. (International Dyer, Aug. 13, 1976).

Laundering and Drycleaning

The Textile Institute, Manchester, England recently published a nomograph on "Laundering and Drylceaning" in its Textile Progress series. This publication is a critical appraisal of recent developments in the area and contains 259 references. The author has included sections on economics, textiles, wash processes, washing machines, calendars, garment-finishing units, tumbler dryers, extractors, laundry effluent, disposables, dry cleaning, and solvent treatment of textiles.

Changes in fibers, fabrics, and fabric finishes throughout recent years have produced new conditions and demands on cleaning equipment to the extent that it is now difficult to determine the process to which a particular fabric or garment should be subjected. An example of this new condition is the use of polyester and cotton in blends. Since polyester is oleophilic and cotton is hydrophilic, it is difficult to remove oil-based stains from polyester in the same treatment used to remove water-based stains from cotton. The author discusses in a less-than-direct fashion the aspects of problems posed by such developments. An interesting development to which he refers is a dual-purpose laundering and dry-cleaning machine.

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Properties of Crosslinked Polymer/Glass Fiber Composites

Mitsubishi in Japan recently reported results of investigations to determine the effects of the application of cyclic uniaxial loading on the viscoelastic response properties of two crosslinked copolymers containing short, randomly distributed glass fibers as reinforcing agents. An additional dispersion had been observed at the higher temperature side of the primary dispersion for cross-linked polymers reinforced with randomly distributed short glass fibers. This additional dispersion disappears by the application of cyclic tensile loads which are less than one-tenth of the static tensile strength, whereas the properties of unreinforced samples were hardly affected by the fatigue. It is considered from these facts that the changes in the viscoelastic properties of composites associated with fatigue are caused by changes in the interaction between the resin matrix and the reinforcing fiber. Experimental data showed that changes in viscoelastic properties are most pronounced when the temperature at which the cyclic loading is applied is near the secondary dispersion temperature. These observations indicate that the changes in interaction between the resin matrix and reinforcing fiber associated with fatigue are considered to be closely related to the absorbing capacity

of mechanical energy of the resin matrix. (J. Applied Polymer Science, Oct. 76, p. 2853).

Coextrusion Techniques for Flame-Retardant and Antistatic Fibers

Considerable interest has developed in the fiber industry by use of additives to develop flame-retardant fibers and anti-static fibers. When additives are used, fundamental questions arise both as to the role they play in the process of fiber formation and the mode of distribution, location, and shape of the additive particles that will maximize their effectiveness. The problems become quite complex when the base fiber-forming polymer and the additives form two phases in the molten state.

The addition of flame-retardant additives to melt spinnable polymers prior to extrusion into fibers is attractive both economically and technically. Considerable difficulties have been encountered in the development of inherently flame-retardant polymers through polymerization. Although many polymers can be coextruded, little work has been done to investigate the location, shape, and distribution of additives within the fiber structure in such a way as to maximize flame retardancy at minimum additive content. The purpose of the work reported here was to determine if a typical flame-retardant component could be coextruded with olefin in such a way as to retain the flame retardant in the core of the fiber. The authors report that they were successful in developing an extrusion technique in which they could not only retain the additive in the core but could also be used to distribute additives at any preferred location in fibers of any cross-section. (J. Applied Polymer Science, Oct. 76, p. 2913).

Cotton/Polyester Blends With Improved Dyeability

An investigation of performance characteristics of a cotton/polyester fabric radiation grafted with a copolymer (allylamine and acrylic acid) has been reported. The fabric was found to take on an amphoteric character because of the fixation of carboxyl and amino groups on the polyester and cotton chains. The result has been that the fabric acquires an affinity for basic and acid dyes, for which the untreated blend components have no affinity. Additional improvements were also reported to be realized; that is, an improvement in resistance to wrinkling of the fabric and increases in breaking strength and elongation. No data were reported on fastness of colors nor range of shades available.

Radiation grafting of flame-retardant polymers to cotton/polyester fabrics has also been reported and represents a means for modification of many fabric characteristics. (Text. Research Journal, Oct. 76, p. 747).

Nonwovens Fabrics Conference

A major conference on formed fabrics was held at Manchester University in England. Twenty papers were presented on various aspects of this topic.

Formation of fabrics from fibrous webs is an integral part of many nonwovens processes. One speaker described a web thickness controller capable of improving uniformity of webs as light as 3 ounces per yard. Other speakers presented papers on binders and bonding techniques. Discussed for the most part were the traditional adhesives and thermoplastic and thermosetting powders. A relatively new innovation discussed was that

of applying PVC plastisols using rotary screen-printing equipment. Bonding of fabrics using binder fibers was also discussed. Such binder fibers could be classified as one of three types: fibers soluble in water, fibers melting partially or completely upon heating, or fibers acting as adhesives, such as undrawn polyester.

Various fabrics now available commercially were reviewed along with fibers that are appropriate for nonwovens. Requirements of fabrics for specific applications - e.g., operating rooms - were also discussed.

Fiber Prices, Demand

Mills are beginning to substitute cheaper man-made fibers such as rayon and polyester for higher-priced cotton in blends. The price of cotton has remained in the neighborhood of 75 to 80 cents per pound for several months and is not likely to drop. Demand for the cheaper man-made fibers has brought about price increases recently.

Over-capacity and depressed markets are still causing problems for polyester multifilament yarn producers. DuPont, for example, recently cut 500 to 600 salaried jobs from their Textile Fibers Department. Yarns of this type are used in textured doubleknit fabrics which have experienced considerable decrease in use.

FTC Care Labelling

At a National Conference on Care Labeling, several speakers approved in principle the concept of care labeling but expressed opposition to some of the revisions recommended by the Federal Trade Commission almost a year

ago. The FTC proposed three revisions involving garments: (1) leather garments to be added to fabric apparel care labeling rules; (2) suppliers of intermediate components to provide instructions for care and maintenance of the components; and (3) changes in the nature of care instructions for increased ease of understanding.

The probable value of care instructions for intermediate components is minor when compared to the probability of providing misleading information. The problems of matching satisfactory components is thought to lead to added costs to the consumer. For example, a lower level of performance would probably be satisfactory for zipper applications; yet the labels contained with the zipper could cause the consumer to spend more for that component than necessary.

Speakers for bleach manufacturers expressed concern for the tendency of garment manufacturers to use "do not bleach" instructions on garments which could be improved by bleaching. Many manufacturers are apparently labeling in this fashion to avoid potential problems.

Apparel Moulding

An International Symposium on Garment Moulding Technology was held recently. The major question addressed by the symposium was the extent to which apparel manufacturing will remain a cut and sew assembly process. Significant advances have been made in recent years. For example, moulded bras were 12-15% of the market in 1972; in 1977, they will consist of 50-60% of the market.

Several conclusions were reached at the symposium as follows:

(1) apparel moulding technology has been developing slowly but steadily in parallel with fiber and fabric developments.

(2) synthetic thermoplastic fibers have made a sound technological foundation for this new moulding technology.

(3) Heat-setting, texturizing, and increased use of knit fabrics have contributed to further advancement of garment moulding.

(4) The development of moulding equipment for apparel products is in its infancy.

(5) Early moulding started with moulded garment parts incorporated into cut and sewn products. The recent trend is toward the moulding of complete garments.

(6) As fashion is keyed into the knit-mould combination, the labor intensive cut-sew assembly methods may be reduced further.

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New Ideas for Doubleknits

The sluggish market for doubleknit fabrics prompted DuPont to sponsor a five-week doubleknit workshop in New York that was attended by over 1200 people and featured over 100 doubleknit Idea Fabrics. A number of new yarns were introduced, including Type 78 Orlon, a new bicomponent cotton system fiber for spun yarns; Type 811W Dacron, a trilobal polyester; Tri-Dye textured filament yarns containing homopolymer and copolymer polyester combined with nylon; TRL-40 textured yarns with spun yarn aesthetics; Taslan textured slub yarns; and space-dyed (intermittent multicolored) yarns prepared by a new process said to reduce dyeing costs by one-half. The most popoular fabrics were sheer knits, sueded surface materials for men's wear, fabrics made from Tri-Dye yarns, and fabrics made from Type 78 Orlon.

Improved Durable Press Emulsion Finish

Dow Corning is marketing a new silicone emulsion finish for durable press fabrics which is said to require less DP resin application, requiring only 50 to 80 percent of amounts normally required for adequate finishing. The new product is reported to be in use presently by several sheeting

manufacturers, with the biggest market expected to be in DP apparel fabrics of heavy and light weights. The product is said to process well under a variety of plant process conditions, and by changing the ratio of silicone emulsion to crosslinking agent, a variety of bonds can be created. Tear strength and abrasion resistance are said to be decreased to a lesser degree. Fabric sewability is improved because of the silicone and absence of organic softeners.

Static Control Nylon

Monsanto has developed a type 66 nylon carpet yarn claimed to have improved static control properties. Additionally, reduced soiling and improved restorability of the yarn after compression are said to be possible A modified trilobabl filament cross section is used to hide soil, while static control is achieved by incorporation of a single conductive filament in the yarn. The conductive filament is made of nylon with a fine nylon/carbon black polymer "stripe" on the filament surface. Field testing has been conducted to verify lab tests on which claims are based and have caused Monsanto to guarantee static control for the life of the carpet.

Other static control developments in nylon yarn include Dow Badische's F901, a simple nylon filament coated with carbon black, and DuPont's Antron III which utilizes three filaments having a carbon black core in a sheath of delustered nylon.

Hospital Nonwoven Fabrics Usage

A survey by Formed Fabrics Industry among hosptials indicated that hospital personnel show great favor toward formed fabrics. A questionnaire

was sent to 1500 hospital administrators and replies were received from 188. The results indicated that as little as $25 and as much as one million dollars per year is spent for nonwoven fabric supplies. Approximately 90 percent of the hospitals replied that they liked the nonwoven products that they had used, whereas 6 percent did not like them. More than three-fourths of the respondents indicated that prices were too high. Underpads were reported to be the most important single item in hospitals, followed by OR/OB packs, face masks, diapers, shoe covers, and caps. The primary value of the products was said to be convenience, manpower conservation in handling products, and time conservation.

Shrinkage Control for Knits

The Sanforized Company has developed a system for providing shrinkage control for open-width knit fabrics. The system uses a crosslinking resin finish and a compressive shrinkage system. The resin finish imparts no-ironing requirements to the fabrics. Appplication can be made to all-cotton and cotton blends in a range of weights of both single knit and doubleknit fabrics. This development eliminates the necessity for knit outerwear producers to process their apparel for shrinkage control. The system is already in place in some mills, and it is expected that fabrics prepared by this system will become available in the Spring of 1977.

Polyester Filament Production

Polyester filament yarn has probably been hit worse than any other major product in the chemical industry this year. The poor business has

resulted largely because of consumer and designer rejection of doubleknit apparel made from polyester. Prices of this yarn have dropped from 87 cents per pound in early 1976 to 50 cents per pound most recently. Several major producers have recently made decisions to drop out of the business and include Beaunit Corporation, Rohm and Haas, and Phillips. Beaunit is owned by El Paso Company which is attempting to dispose of the fiber-producing facility, but the company indicates that fiber and textile production will continue through negotiations for disposal. There are a large number of minor polyester filament producers many of whom are undoubtedly out of business.

The previous reference to DuPont's activities to improve demand of doubleknits indicates the direction of developments in polyester filament yarns. Other developments include yarns having cross sections different from the conventional round and pentalobal yarns that the trade has produced up to now. A greater selection of fine denier yarns is predicted, with one company to announce shortly a new 50-denier yarn designed for circular knit fabrics and having aesthetics different from the 70-denier yarns currently being promoted. Yarns heavier than the most common 150-denier yarns are also planned, principally for sweater knit constructions.

A significant effort is reportedly being mounted in the polyester filament industry to develop yarns possessing a spun look. It is questionable whether these yarns will appear in the market before late 1977. Results will be slow largely because of the technical problems associated with modification of physical characteristics simulating the spun yarn appearance. One producer claims that the average consumer will not be able to differentiate between his spun-like multifilament yarn and spun yarn.

Miscellenous New Products

A representative of a large fiber producer has indicated that second generation spunbonded fabrics are in the latter stages of development and will be forthcoming. Such fabrics are anticipated to have improved drape and hand characteristics. In this connection, it has been learned that DuPont's spunlaced products will dissolve in softeners often used in laundering.

Fiber producers are also reported to be developing polyester fibers for carpets capable of being dyed without carriers. Previously mentioned (July report) was Eastman's Kodel V.

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Compression Behavior of Wet Fabrics

The Textile Research Institute has had under development for some time a technique to monitor pressure changes occurring as a liquid is forced through a textile structure at a constant flow rate in the direction perpendicular to the fabric plane. The pressure-time profile constitutes a record of the fabric's response to initial wetting and resistance first to passage of the liquid front through the dry fabric, and then to sustained, steady-state flow through the wetted fabric (viscous drag). It has been assumed that these responses depend chiefly on the inherent wettability of the fibers and the construction of the fabric. An additional factor probably complicates attempts to compare fabrics with regard to their flow-through behavior. Forcing a liquid through fabrics compresses them to different extents and changes their pore structure. Because of a lack of information on the wet compressability of fabrics, TRI has initiated a study of compression characteristics of wet fabrics as a function of water temperature. This information will be used to study flow-through behavior on the basis of fabric parameters such as wet thickness and porosity.

Interest in Tris FR Fabrics Declining

Interest in the use of "tris" flame retardant for children's sleepwear has dropped considerably, according to reports in the Daily News Record. Major retail chains are reported to have decided not to buy merchandise containing tris beginning next fall because of the cancer scare that developed a year ago. Several new candidates for replacement of this chemical exist but are reported to have drawbacks such as difficulty of application and environmental pollution.

Growth Rate of Carpets

The most recent 5-year industry forecast of carpet and rug shipments in the United States was published in the November issue of Modern Textiles. The Carpet and Rug Institute predicts substantial growth through 1981, with an annual growth rate expected to average 9% per year, based on number of square yards. Tabulations of data show industry shipments for each year from 1975 through 1981. Carpet types are broken down into wovens, tufted, and other.

Nomex Bedding and Sleepwear

A Los Angeles linen supplier has introduced a complete line of bedding and sleepwear of Nomex aramid fiber for use in hospitals, nursing homes, and penal institutions. Nomex is DuPont's high temperature resistant fiber which is widely used in critical flame resistant applications. It is reported that the products are easily maintained and offer good resistance to commercial laundering. Products made from Nomex for use in these institutions include pillows, pillowcases, mattress covers and pads, sheets, blankets, infants' gowns and pajamas, and adult patients' gowns. The cost for bedding and

sleepwear is reported to be about four times that of conventional materials, but the wear life is said to be six to seven times longer.

Moisture-Absorbing Acrylic Fiber

Chemical and Engineering News reports that a West German fiber producer has developed a light weight acrylic fiber which has the capacity to absorb large quantities of moisture compared to most textile fibers. The fiber is said to have a physical structure different from other textile fibers in that it has numerous capillaries embedded in a dense sheet that protects them from damage in processing and in use. Moisture can pass from the outside to the porous fiber core through these capillaries, allowing the fiber to absorb water to about the same extent as wool. Unlike wool, however, the fiber does not swell appreciably during the water absorption. Dampness does not become perceptible to the wearer of fabrics made from the new acrylic until it has absorbed about 19% moisture compared to 13% for wool and 11% for cotton. In addition to being quick drying, the low density of the fiber is claimed to permit a 25% saving in material in clothing when compared to conventional acrylics. The company is now producing the fiber in pilot-plant quantities.

Textile Dryer Constructions and Drying Techniques

An article in the Dyeing/Printing/Finishing issue of the International Textile Bulletin discusses various issues related to the removal of water from textile materials. The need to differentiate between the various ways that water is attached to the fibrous material, the type of attachment, and the intensity of the bonds with the dry fiber is noted. Various mechanisms of water attachment are surface attraction, capillary action, and chemical

attraction. The features of conventional textile dryers used in processing and finishing textile fabrics are compared, including radiation dryers, cylinder dryers, perforforated drum dryers, sieve conveyor dryers, hot flue and festoon dryers. Dryers that are still in the experimental stage and dryers using other principles of energy development such as high frequency and microwaves are also discussed. These new dryers are all designed to make the drying process more efficient and less costly.

U.S. Man-Made Fiber Producing Capacity

The Textile Organon reports that in November, 1976 the U.S. man-made fiber industry had capacity to produce 11,242 million pounds per year. This capacity represents an increase of 6% over the capacity in place a year earlier. By November, 1978, total man-made fiber producing capacity is expected to expand by 10% to 12,369 pounds annually. Capacity by type of fiber group in million pounds is:

	November	
	1976	1978
Cellulosic	1,193	1,193
Non-Cellulosic	9,156	10,079
Textile Glass	893	1,097

In the Organon's survey, all productive equipment which is currently or is projected to be in operable condition is counted as capacity regardless of whether it is actually producing fiber at the time the capacity measurement is taken.

Of cellulosic capacity, rayon filament yarn has been reduced to 85 million pounds per year, an amount about one-half of capacity two years ago. Acetate yarn has increased slightly to a current figure of 399 million pounds and is

expected to remain constant for the next two years. Rayon staple and tow capacity showed a 6% decrease in 1976 and is projected to level off at the current figure of 691 million pounds. Acetate staple and tow capacity has not changed and is not expected to change at 18 million pounds.

Non-cellulosic fiber capacity is slated to increase 923 million pounds over the next two years. This increase compares to an increase of 720 million pounds per year in 1976. Just more than half of the future growth is expected to occur in polyester fibers and filament yarn, in spite of the large unused capacity presently installed. In nylon, the capacity increases are aimed mostly at servicing the floor covering market. Capacity for carpet yarn is expected to rise by 179 million pounds, and nylon staple will increase by 159 million pounds. Nylon capacity for textile fabric applications is expected to increase slightly, while industrial yarn capacity will decrease.

Acrylic and modacrylic staple and tow is not expected to change in the next two years. Olefin yarn and fiber capacity is expected to increase approximately 8% to 930 million pounds.

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Sonic and Supersonic Vapor Flows in Drying

An invention, called the Machnozzle, was described at a recent AATCC symposium. Designed and investigated by a machinery builder in Holland, the Machnozzle creates a very high flow of steam or gases through fabrics. In this way, water and other residual material entrained around and in the yarns will be virtually blown out of the fabric. It is evident that this development leads to an enormous increase in washing action and a considerable improvement of the moisture removal efficiency when it is used in various textile preparation and finishing operations. An important advantage of this device in comparison with other high-efficiency squeezing systems is negligible energy consumption.

Steam (or air) is fed by a pipeline in the Machnozzle to a buffer chamber inside the apparatus. It then passes through a very narrow channel where the speed of the steam increases enormously. At the end of this channel, the steam is forced to penetrate the fabric. Suitable performance requires that the cloth not be blown away from the nozzle; therefore, the outlet of the nozzle is designed to be very small so that relatively small tension in the fabric is required. The radius of the Machnozzle used for textile dryers is about 0.1 inch. Construction of the channel leading to the exit is such that supersonic speeds of the steam can be obtained.

The depth of the channel is relatively large in comparison with the distance between the walls. This design permits a pressure drop of the steam which exceeds by several times the pressure drop across the fabric. The vapor leaves the nozzle uniformly over the total width of the exit slit and does not follow a path of least resistance in the case where the width of the fabric is narrower than the width of the nozzle slit. The opening slit of the Machnozzle is only 25 microns. Experiments on pilot plant and production bases have shown that even light-weight, fine fabrics with high yarn slippage were not disturbed by the steam jet.

Residual moisture in fabrics after drying by the Machnozzle is 10 to 40% less than that remaining from high-efficiency squeeze systems. Typically, residual moisture for fabrics of various types is 0 - 25% for polyester, 20 - 40% for polyester/cotton, and 30 - 50% for wool.

Soft Goods Outlook for 1977

Kurt Salmon Associates has published their forecast of textile industry activities for 1977. They state that no single issue will override activities related to the textile economy, but rather a number of problems will contribute to an overall sense of uncertainty, caution, and quietude. Compared with the exciting year-to-year advances of 1971 - 73, and the three roller-coaster years that followed, 1977 may seem tame. Since mid-1976, the soft goods industries have been settling into a tighter, narrower, more normal operating mode, except that "normal" is no longer what it used to be. Some of the new rules to be followed are listed below.

Growth is not guaranteed. Personal consumption expenditures for apparel has stabilized at 6.1% of the consumer's income, down from 6.3% in 1973.

Overcapacity. There appears to be enough capacity at most stages of the soft goods chain. Synthetic fiber production has over-capacity, and retailing has more stores than it needs.

Imports are growing. More than 20 percent of all apparel units purchased last year were produced elsewhere.

Competition. It is harder to earn a profit because of the growing number of large firms.

Fashion without direction. Fashion obselescence is no longer a powerful force. Few customers are willing to scrap last season's wardrobe.

Overall, KSA sees a growth rate in apparel fabrics of 2 - 3%, carpets and home furnishings of 7 - 10%, and auto and industrial fabrics of 8%.

Role of Textiles in Personal Injury Burn Cases

The Institute of Textile Technology has published results of a study made at the Burn Unit of the University of Virginia Medical Center. The study was made to determine the true role of textiles in burn injury and property loss accidents.

A detailed study was made over an eight-month period because of an apparent inconsistency between the basic flammability properties of most textiles and descriptions of burn injuries in reports. Garments were not involved with the burn injuries in all cases. Of 42 cases, 24 involved fabric ignition while 17 did not. In some cases, it was observed that the garments

played a protective role; in other cases, second and third degree burns were inflicted in areas of the body where the garment did not ignite. In most cases where the garments ignited and severe burn injuries resulted, factors such as intoxication, medication, physical impairment, and psychosis limited the ability of the victim to react. It appears that the behavior of the individuals and the circumstances surrounding the incidents had a greater role in determining the nature and extent of burn injuries than did the flammability characteristics of the fabric itself.

A strong implication of this article was that education of the consumer would be of greater benefit in preventing fire injuries than would be the development of flame retardant fabrics. The idea is not new, of course, but these topics seem to appear in cycles. Several other articles were noted in various publications, with all of them pointing to improved consumer awareness of the susceptibility of clothing to burning.

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CPSC Furniture Flammability Code

Proposed flammability standard for upholstered furniture is estimated to cost industry from $311 million to $656 million annually. The Commission's own estimates indicate that the standard would cost the industry $28 million for testing alone during the first year. Fabric treatment might add $15 to $20 per chair and $15 to $40 per sofa at retail, raising retail prices an average of 13% to 27% and reducing the number of furniture styles available to the consumer. The Upholstered Furniture Action Council has proposed a voluntary standard, holding that the Commission's proposed standard is not needed, reasonable, appropriate, nor technologically practical. The Council urges an educational consumer campaign to develop a sensitivity in the consumer to the dangers associated with flammability of upholstery.

Effect of Toxic Substances Control Act

The Geigy Company, manufacturers of a large variety of chemical finishes, agents, and dyestuffs for the textile industry, reports that the Toxic Substances Control Act which was made effective January 1, will force many chemical companies to reduce the size of their lines and even go into a "custom" basis businesss and not carry any open stock. Also, chemical companies will be developing fewer new products for the textile industry. Customers

will be forced to substitute other colors for desired colors in dyeing or printing. The problem arises because the Toxic Substances Act requires testing and pre-marketing notification of newly developed chemicals. Textile companies will have to find ways to modify their chemical applications to get the desired effects within the constraints of old products that are exempt from the Act. The EPA is reported to have a flexible attitude in the way in which it will administer the Act. While it might allow a firm in one location to manufacture or use a product, it may prohibit its production or use by a firm in a different part of the country. Its decision could depend on such factors as current pollution conditions in an area, the number of employees in a plant, or the population density of a location.

Productivity in the Apparel Industry

An examination of the state of the apparel manufacturing industry in the U.S. indicates that the industry lags the world in the development and application of new technology. Foreign countries are reported to have adopted new equipment more readily because most of it is manufactured in foreign countries, consequently it is relatively less expensive, and because of a relatively tight labor supply. Work practices in most foreign countries are such that individuals are less productive than they are in the U.S., consequently more labor input is required for a given quantity of output. American workers are much more productive because of their superior abilities. In spite of this advantage, the lead of the U.S. apparel industry in productivity has been substantially diminished in recent years, with other countries catching up and closing the gap. Apparel industry leaders have

noted that the governments of foreign countries actively support associations and research organizations endeavoring to advance technology in the textile and apparel industries. Their support goes beyond that of the Federal government to recommend, support, encourage, and stimulate, to funding of research work leading to productivity improvements. The need for financial support of the apparel industry is being expressed.

Through-Drying of Textiles

In conventional textile drying systems, moisture is driven from the fabric surface by air impingement or temperature differential. In the through-drying process, air is forced directly through the wet, fibrous web to remove moisture. Through-drying incorporated in some textile drying equipment is essentially an adiabatic heat transfer process. Heated air is passed through the sheet so that the heat is transferred from the air to the moisture, and the moisture then evaporates from the sheet. The heat transfer process results in the air being cooled along an adiabatic saturation line. Depending on the heat source available, the equipment, and the nature of the product, moisture pick-up much greater than expected can be obtained. For example, in a continuous line dryer divided into several temperature-pressure zones, it is possible to cascade from one zone to another to achieve operating economies.

Flammable Fabrics Legislation

Knitting Times reports that chances are strong that 1977 might become the year the prevailing law on flammable fabrics undergoes its most sweeping

change. A strong and persistant effort is being steadily waged by consumer groups to develop a new standard for flammability of general wearing apparel. They want a standard that will bear a more realistic relationship between the safety of the clothing and its burn potential to the wearer. The apparel industry, cognizant of the criticism directed against the current flammability standard, CS-191-53, and recognizing its obligations to provide the consumer with safe products at reasonable prices, is presently analyzing CPSC's apparel burn accident reports to ascertain specific areas that may require additional regulations. Additionally, the National Knitted Outerwear Association is making an effort to develop a reasonable and practical test method. A test program involving 50 widely used apparel fabrics, 13 different labs, and 17 different test procedures is being conducted. The objective is to determine by several simulated accident methods, the possible hazardous effect of fabrics made up into prototypes of typical garments. Efforts will be made to relate accident simulation data to existing tests including those presently in effect and to proposed tests the government has under consideration.

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Graphite Fiber Development

Hercules, Inc. has announced the development of a continuous filament graphite fiber priced at a lower price than previous graphite products. The cost is $18 per pound compared to a previous low price of $32 per pound. The filament is made from a precursor of polyacrylonitrile, has a modulus of 32 million psi and a tensile strength of over 400,000 psi. The lower price will undoubtedly broaden usage of the fiber in composite material applications.

Solar Energy Applications in Textiles

A recently completed feasibility study by ERDA indicates that solar energy can be used for heating water; however, its utility is not practical at the present time. Solar heat collectors would have to cost no more than $10 per square foot to compete with conventional energy sources. The current price of collectors is about $30 per square foot, and the General Electric Company, which conducted the study, says that at the present time, the textile industry would be better off investing its money elsewhere and using the income to pay the higher fuel bills. The study was made at LaFrance Industries in South Carolina, an area where dyeing and finishing mills are concentrated.

A second study is being conducted at a finishing plant in Alabama by the Honeywell Company to add to the data base.

Because of these studies, the textile industry now has a better idea of how much energy it needs. Many opportunities for conservation of energy have also been found. In terms of energy use for wet processing, textile mill products are the fourth largest industrial classification, using 7 to 9 percent of the total fossil fuel consumed by industries using hot water and low grade steam for their processing.

Apparel Manufacturer's View of Care Labeling

Testimony given by American Apparel Manufacturers Association spokesmen at hearings on the proposed care labeling revisions by the FTC was recently published. The present rule requires the apparel manufacturer to fully inform the purchaser how to provide regular care and maintenance as is necessary to the ordinary use of the article. The proposed rule incorporates similar language but then goes on to require specific instructions for each item of apparel. Where the present rule lists examples, of care procedures that might be necessary for particular garments, the proposed rule requires detailed instructions for all garments. AAMA states that the difficulty with this new approach is that it assumes that technology will not change and that clothes will be cared for in the future as they have been in the past. It is the Association's opinion that the proposed rule would have the effect of discouraging developments of new methods. It is AAMA's opinion that what the American consumer wants and needs are care labels that are brief and easy to read, and which allow clothes to be cared for with a minimum of time and expense. The best way to achieve this result is to warn the consumer about what not to do.

A significant issue is the requirement of the proposed regulations to require that use and type of bleach be specified when all available bleaches

can not be used. AAMA feels that this requirement has the effect of promoting the use of a particular commercial product - that is, bleach - and that similar positive instructions would have to be developed for pre-spotters, pre-soaks, softeners and other optional products. The organization prefers that bleach instructions should be included only when bleach is required as a regular care procedure for a particular item.

Radio Frequency Drying in Textiles

Significant improvements in product quality and a reduction of over 60% in cost of drying textiles after dyeing are claimed to have resulted from an installation of a radio frequency dryer, as reported in Textile Manufacturer. Conventional methods of drying inevitably lead to the exterior of a package being dryer than the interior, and this uneven moisture profile can lead to difficulties during subsequent processes. Radio frequency drying prevents this problem since heat is generated evenly throughout the mass of the material by the rapid reversal of polar molecules. Objects can be heated at the center and at the surface simultaneously without the delays associated with conventional heat transfer. Water absorbs this form of energy readily, while most textile fibers absorb much less energy from the same radio frequency field. In a wet mass of fibers, the wetter areas will heat most and the energy absorbed will diminish with the moisture content until the areas with no free moisture will absorb almost no power. The fact that radio frequency energy is only consumed in proportion to the moisture content of the product being dried contributes to the reduction of energy costs of over 60% compared to methods conventionally used.

Acetate

The DuPont Company has ceased the manufacture of acetate yarn, a product it began to produce in 1929. Three major producers of acetate remain, -

these being Avtex, Celanese, and Eastman. This product is used largely in the manufacture of tricot fabrics for lingerie and intimate apparel as well as for a number of outerwear end-uses. Acetate has declined in usage in recent years, with shipments decreasing more than 26% since 1970. This decrease in usage is largely attributable to the swift rise of polyester and, in the last year, to the changing relationship between the price of polyester and nylon, on the one hand, and acetate on the other. Historically, acetate has always been a much lower priced yarn than either polyester or nylon. However, business conditions of the past two years have caused the prices of nylon and polyester to drop to the extent that acetate is no longer the bargain it once had been. Acetate had also been the major raw material for double knit fabrics, but as textured polyester became more popular, the demand for and interest in textured acetate yarn for double knits declined swiftly. Industry observers view DuPont's exit from this market only as a strengthening of its position in fibers and not because acetate might be a fiber of the past.

Laundering of Open-End Spun Yarns

A study of the effects of laundering on the performance of open-end and conventional spun yarns in jersey knit fabrics has been reported. In this work, bleached all-cotton and 50/50 cotton-polyester knit fabrics were used as experimental material. They were constructed similarly from open-end and conventionally spun yarns of appropriate size and twist for knitted fabrics. The performance properties of the fabrics were evaluated initially and following 5, 15, and 25 launderings. When the physical characteristics of the fabrics made from open-end spun yarns were compared with those of conventionally spun yarns, the fabrics made from the open-end

spun yarns displayed superior resistance to pilling, slow wickability, and good dimensional stability. Because of the compactness of the open-end spun yarns, these yarns experienced the least amount of compression and the greatest percentage of recovery. Fabrics made from open-end spun yarns had lower bursting strength and resistance to abrasion because of the lower strength of these yarns. Pilling resistance results were surprising but can possibly be explained by the relatively higher twist of the open-end yarns. Another factor may have been the decreased hairiness of the open-end yarns with fewer protruding surface fibers being available to form pills.

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Celanese Yarn With Spun Characteristics

Celanese Fibers has announced that it will market a new polyester filament yarn with spun-yarn characteristics, to be trademarked Lambda. Initially, the yarn will be sold in sizes equivalent to traditional worsted spun yarns for knitting and weaving. Fabrics made from this yarn will initially be used in women's apparel and will appear in 100 percent form and in blends with other products. Fabrics produced to date with the yarn have been blends of this yarn with polyester textured yarn and with spun yarns. Yarns for knitting have a circular cross-section to facilitate the knitting process and knit fabric performance, and will represent a slight disadvantage to achieving the spun-yarn look. Yarns for weaving are hexagonal in cross-section and will have a rougher texture.

Energy Storage in Residential Appliances

We noticed in a solicitation of research proposals that the Union Carbide Corporation will sponsor research on energy storage in residential and commercial appliances. As we obtain more information, we will report further.

Antistatic Agents

Work continues on the development of durable antistatic agents. A patent issued to ICI United States, Inc. in December, 1975 claims that durable antistatic and antisoiling properties are imparted to static electricity - generating textiles by a treatment with carbamic acid esters containing thermally labile carbamic acid ester groups and thermally stable carbamic acid ester groups derived from a cationic surfactant. Polyester fabric samples were padded to 67 percent wet pick-up with an aqueous dispersion containing a compound meeting the above description. The treated fabrics after drying and curing showed significant antistatic properties which remained unchanged after ten washings.

Government Recall of Sleepwear

Considerable attention has been given the Consumer Products Safety Commission's action to remove from the market place all children's sleepwear treated with tris 2,3 dibromopropylphosphate, a compound thought by CPSC to be a hazardous substance. Initially, CPSC applied its action only to garments, but a U.S. District Court judge directed the Commission to include garments, fabric, yarns and fibers, and the chemical itself when intended for use in children's wearing apparel.

CPSC initially placed the financial burden of the recall directly and almost entirely on children's apparel manufacturers. The apparel industry argued in Federal Court that the CPSC decision would result in bankruptcy for many of them. The apparel industry claimed that the economic burden should be passed to those who applied tris to the fabric - the

textile industry. The court ruled that all parties in the chain of apparel manufacture would be required to refund the purchase price of tris-treated goods they had sold.

Several appeals to this decision have been made by the textile industry and by a group of small apparel producers. The latest development is that CPSC has apparently determined voluntarily that its recall order should apply to all parties in the manufacturing chain, which may make any court decisions moot.

An interesting point is CPSC's contention that apparel which has been washed is not a hazardous substance.

Developments in Polyester

A number of reports on fabric developments from conventional polyester yarns have been noted. These developments result from the tremendous depression of polyester yarn and fabric usage last year and represent attempts to increase the polyester market again.

Principally, polyester doubleknit fabrics are aimed toward the women's wear market as sportswear and dresswear. The men's wear market is more difficult because men's doubleknit slacks have been a low-priced discount store item for some time. Most women's wear fabrics are being made as light-weight fabrics compared to previously heavy fabrics. The heavier weight goods are being developed as suede-like, corduroy-like, or natural look fabrics. Many will have a more expensive look, but although they appear to be normally "dry clean only" fabrics, most should be washable.

Other polyester fabric developments are aimed at improved comfort through improvement of its water absorption characteristics. Although moisture absorption and transport do not necessarily add up to comfort in wearing because other factors contribute to comfort, many manufacturers are pursuing this approach. Two textile manufacturers - Stevens and Milliken - developed hydrophilic finishes for polyester fabrics and have supplied fabrics for several years under their trademarks. However, Dupont recently introduced a polyester fabric finish called Zelcon which combines improved moisture absorbency and transport along with soil release and antisoil redeposition characteristics. There is much speculation in the industry that DuPont's efforts may develop a real impetus for polyester fabrics, particularly since its introduction coincides with other polyester fabric development efforts designed to renew consumer demand. To be effective, the finish must be applied at a concentration of 4% on the weight of the fabric. The finish does not dissolve during laundering but wears off gradually over a prolonged period of time. DuPont indicates that the finish will withstand 35 to 50 launderings.

Similarly, ICI is currently marketing a product known as Milease T, a finish said to add comfort to fabrics. The finish is described as a durable finishing agent which imparts soil release, antistatic properties and increased water absorbency to 100% polyester fabrics. ICI recommends application at 4-7% on the weight of the fabric.

In another development, DuPont has developed a polyester fiber specifically for denim fabrics. Demand for denims continues to remain strong and has been a principal factor in the increased price of cotton

and the decreased utilization of polyester sports and dresswear fabrics. Denims are generally made from 100% cotton. It should be noted that denims made of a cotton-synthetic blend have existed for sometime. However, these fabrics lacked two features: they did not fade with repeated launderings and they didn't get softer with wear. DuPont's new fiber provides these characteristics along with high shrinkage not normally characteristic of polyester. Denim fabrics are made from 65% cotton and 35% polyester. The costs of denim made from the blend will be less than that made from 100% cotton. In addition, benefits of improved tear strength, smoothness retention and faster drying should result.

Nonwovens in Home Furnishings Applications

A review of nonwoven fabric applications in home furnishings was made recently. Many uses for nonwovens are based on their price/performance properties rather than their aesthetics; however, some areas exist where nonwovens are gaining acceptance where aesthetic properties are important.

In carpet backings, nonwovens have been used as primary backings since 1965. Nonwoven secondary backings have been used for about eight years. Applications are also seen where nonwoven fabrics are used as reinforcement in carpet underlayment.

In curtains and draperies, nonwovens have been used long-term in header materials. These fabrics are generally stiff, made from coarse natural fibers that are chemically bonded. Casement fabrics are made from a specific nonwoven process known as the Malimo process, with the greatest quantity of fabric in use being made by this process.

Inroads are being made by the spunlaced nonwoven fabrics (about which we have commented several times) as drapery and curtain fabrics. Most of these fabrics are currently made of 100% polyester staple fiber. The fabrics are made by a hydraulic needling process developed by DuPont. The fabrics dye and print very well, and can be readily quilted or joined by sonic power techniques. One of the chief factors in spunlaced materials achieving penetration of the drapery and curtain markets has been pricing in relation to woven fabrics on a per yard basis.

In bedding, nonwoven fabrics are finding application as quilt backings, bedspreads - particularly spunlaced fabrics - , mattress ticking, and mattress pads. Many nonwovens are also being used as dust covers, spring insulators, and spring supports in mattresses.

Nonwovens are finding extensive application as substrates for vinyl coated upholstery. Other furniture applications include non-cover uses as spring insulators and spring supports.

Nonwoven products will continue to grow in selected but not all home furnishings end uses. In applications where low-weight fabrics can be used such as mattress pads and quilt backings, nonwovens will continue to challenge woven products. In decorative applications, spunlaced and stitchbonded products have a good opportunity to penetrate the curtain, drapery, and bedspread markets. However, competition will continue to be keen from knitted and woven products.

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Flame-Resistant Fabric Without Chemicals

An alternative approach to the production of flame resistant warp knitted fabrics for sleepwear and loungewear had been developed by Guilford Mills. The warp knit fabric is made from polyester and is made flame resistant without recourse to FR chemical additives. The fabric's flame resistant properties are achieved by a proprietary finishing process that is said to use selective dyestuffs and at least three additional chemical and mechanical finishing steps after knitting.

The fabrics are said to meet the requirements of both the DOC-3 and FF-5 children's sleepwear flammability requirements. Guilford indicates that both have passed the Ames test which determines the mutagenic properties of chemicals, the principle being that if a chemical is mutagenic, it will also be carcinogenic. Tests for toxicity of chemical finishes used are not complete.

Guilford claims that their process can be used on fabrics that will meet 90 percent of the consumer's requirements. Exceptions cited are fabric styles having 80 percent or more print coverage. Fabrics made flame retardant in this way also include brushed fabrics and flannels.

CPSC and Flammability Regulation

The Consumer Product Safety Commission recently discussed its present position and future direction relative to flammability of textiles. Presently, there are four regulations in effect under the Flammable Fabrics Act. The

Commission is currently studying in depth the possibility of issuing flammability standards in two additional areas.

First, CPSC is relatively close to finalizing its stance on a flammability standard for upholstered furniture. It has to date undertaken a thorough examination of injury and fire incident data to aid in a decision on need for a standard and to determine the expected accomplishments if one were issued. It has sponsored laboratory research to develop test methods and criteria that might be incorporated in a standard. It has also collected economic data to predict the effect of a standard on the upholstered furniture market. In reaching its ultimate decision, CPSC states it will first have to decide on the seriousness of the risk of injury or death presented by upholstered furniture. It will then have to decide whether the proposed standard will reduce that risk commensurate with the likely impact it will have in the market-place.

A second area in which CPSC is studying the possibility of flammability regulation is general wearing apparel. Two approaches have been reviewed, one being to upgrade the existing CS 191-53 standard that applies to all wearing apparel fabrics, and the other to apply a somewhat less rigorous modification of the children's sleepwear standard to certain selected types of garments that injury data show present significantly higher risks of injury than most other garments. The major feature of CS 191-53 modification is to change the test method used. A so-called "mushroom tester" (relating to the physical appearance of the test equipment) has been developed with which the ease of ignition of fabrics and the rate of heat release of the fabric once it has been ignited are measured. The latter is the novel and more significant feature since the seriousness of the injury that results from a wearing apparel

fire depends on the heat released by the burning fabric and transferred to the victim's body. If CPSC were to opt for extending the children's sleepwear standard to other specific items, it is likely to suggest that it be done for nightgowns, womens' robes and housecoats, men's and women's pajamas, dresses, men's shirts and men's trousers.

The National Advisory Committee for the Flammable Fabrics Act has been following closely the Commision's work on both upholstered furniture and wearing apparel. It has endorsed moving ahead with an upholstered furniture standard, but has not developed a clear consensus on wearing apparel.

Nonwovens as Reusable Garments

The DuPont Company recently described procedures it is using in utilizing industrial and linen service laundries as distributors for reusable garments made from nonwoven fabrics. A few such companies have begun limited distribution of disposable garments, usually as a convenience for regular customers. Arguments cited against distribution of disposables are high unit costs; poor durability; fouling of washes by disposables mistakenly thrown in the collection bin; and high cost per use. With resistance to use of nonwovens caused by experiences with disposable nonwovens, acceptance of reusable nonwoven garments has met with some difficulty.

Basically, DuPont develops specialized laundering procedures for specific fabric applications. These procedures must be able to remove difficult soils with no economic penalty to the laundry. Drying and finishing requirements must be compatible with existing equipment. Special technology such as reapplication of antistat for operating room garments must be established and

proved. To show that the use of such garments can be profitable once the above technical information has been developed, the garment producer must identify applications in which the garments can be used profitably.

Fertile areas include those in which reusable woven garments have a history of high garment damage or loss. Non-launderable soils such as silicone rubber used to seal heart pacers build up on a garment and make it unacceptable after three to five wearings. Coveralls used in paint spary booths are hard to launder.

DuPont estimates that an industrial laundry can charge the same rental price for both woven and nonwoven garments and break even on the reusable nonwoven even before it is washed. If the garment is laundered and reused six to ten times, profit after laundering and delivery costs can be five or more times than that normally made by selling single use items.

Effect of Fabric Construction Variables on Soiling

A study of the effects of fabric construction variables was made by Georgia Tech graduate student, Maura Schrier, with the assistance of a Whirlpool fellowship. This work was prompted by problems of nonuniformly-soiled soil cloths which the Laundry Group uses to evaluate the cleaning efficiency of washing machines. Preliminary evaluations of nonuniformly soiled soil cloths indicated possible effects of differences in yarn size, yarn twist, and the extent of interlacing of yarns in the fabric (yarn crimp) to be associated with differences in soiling. The soil cloths are purchased from a commercial laboratory and the nonuniformities in soiling cause considerable care and extra work to assure that reproducible results are obtained in evaluations of washing machine efficiency.

In her research, Ms. Schreier varied systematically the size of yarns in the fabric, amount of twist in the yarns, and the extent to which the yarns were interlaced over wide ranges. The yarn variables were incorporated in the filling (widthwise) yarns, while the warp yarns were held constant. Samples of fabric incorporating the yarn variables were soiled in a synthetic soiling solution following a procedure which was developed to assure that the soil was applied uniformly both within samples and among samples. The extent of soiling was measured spectrophotometrically.

The results indicated that only one of the variables - the amount of yarn crimp in the woven fabric - was associated with variations in the amount of soil taken up by the fabric. There were no differences in soiling evident with variations in the other variables. The differences associated with crimp level were also evident after washing.

The results were encouraging in that the differences observed possibly explain the source of some of the variations observed in commercial soil cloths. They are discouraging in the sense that this variable can be controlled less satisfactorily than other weaving variables.

People Returning to Dry-Cleaning?

An article in the Philadelphia Inquirier recently indicated that dry-cleaning business has begun to increase after noticeable downturns from 1971 to 1976. The dry-cleaning business was decimated by the perfection of wash and wear fabrics ten years ago after having survived the challenge of coin-operated dry cleaning machines. In the eight-county Philadelphia area, the federal Bureau of Labor Statistics estimates that between 1971 and 1976, the number of dry-cleaning industry workers dropped by one-half.

Dry-cleaners are optimistic that the renewed popularity of natural fabrics and unhappy experiences with do-it-yourself cleaning are bringing people back to professional dry cleaners. Cleaners indicate that in polyester fabrics particularly, oily stains disappear when they dry. The housewife will then wash a stained garment, the stain reappears, only by that time the heat has set it and its much more difficult to remove. It is the home cleaner's dissatisfaction with his efforts to remove stains and produce a refurbished garment having good appearance that is causing him to return to dry-cleaning establishments, so Philadelphia area cleaners say.

An innovation attracting additional business is a guarantee that a person is better off entrusting his cleaning to a professional than trying to do it himself. In the guarantee, the cleaner agrees that if any garment he accepts for cleaning is damaged he will make certain that the customer is reimbursed.

Recent Developments in Qiana Nylon

Qiana is a trademark of the DuPont Company applied to specific nylon yarns in fabric form that meet certain minimum performance requirements. The continuous filament yarns used in making fabrics of Qiana nylon are expensive but they offer the unique combination of ease-of-care and luxurious tactile and visual aesthetics normally associated with the finest natural fibers. Because of their cost, fabrics of Qiana will compete only in the top 15-20 percent of each of the end-uses benefiting most from these product attributes. Although Qiana fabrics have been marketed world-wide for several years, volume has only recently reached a level of importance in the textile processing industry.

Qiana has a lower specific gravity than that of nylon 6-6 and polyester. Although the melting point of Qiana nylon is higher than either of these fibers, its softening temperature is about the same. Secondary transition temperature is much higher and results in improved wrinkle resistance and recovery from deformation and increased responsiveness to texturing, a process which imparts bulk to the yarn.

DuPont expects sales volume to grow at a moderate rate through the remainder of the '70's, but this growth will not be accompanied by the sort of fiber price reductions seen in earlier new fiber ventures.

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General Apparel Flammability Standard

The National Advisory Committee for the Flammable Fabrics Act has reported that information on burn injuries needed to justify a general wearing apparel flammability standard is insufficient to justify promulgating such a standard. The committee advises the Consumer Products Safety Commission on flammability matters related to textiles. A recent review of burn injury data obtained by CPSC suggested "absolutely no need" for a general wearing apparel standard. The data base was described as bits and pieces of information which may suggest a need for a specific item standard, but data of this type was described as insufficient, also.

The advisory committee members report that they have consistently asked CPSC to develop information which they believe is necessary for a recommendation. However, CPSC has not worked to develop such information CPSC generally relies on the National Electronic Injury Surveillance System which derives injury data from 119 hospital emergency rooms. During 1975, this system showed that 3,903 persons received hospital emergency room treatment for burns from fabric ignition. Critics of the system believe that data obtained are not representative of injuries received from burns and that it is not possible to predict accurately which age groups face the most severe burns from given types of clothing.

Carcinogenic Textile Chemicals

The Environmental Defense Fund has developed a list of ten chemicals used in textile finishing that are known carcinogens. The chemicals are part of a list of chemicals that have not yet been adequately tested under the Environmental Protection Agency's Substances Control Act. Many of these chemicals are formaldehyde-based and are used in durable-press treatments. Others are used for waterproofing fabrics and imparting other unique fabric characteristics.

The organization does not plan to petition CPSC for a ban of products containing these chemicals since the government is presently taking an inventory of the apparel and textile industries. Firms using these chemicals must indicate the names of substances used no later than November, 1977.

The Environmental Protection Agency has begun a risk assessment of acrylonitrile, benzidene, and vinylidene chloride. All three chemicals are important to the apparel and textile industries. Acrylonitrile is used to make acrylic fiber. The DuPont Company has stated publically that this chemical may be carcinogenic to workers in textile fiber plants. Benzidene is used as an intermediate in the manufacture of a number of dyes, while vinylidene chloride is used in the manufacture of a number of plastic materials.

EPA is presently awarding contracts for risk assessment studies of these chemicals which are expected to require from four to eight months. The examination of these substances will include an assessment of hazard, a review of the sources of the chemicals or the circumstances under which the hazard is produced, a study of possible substitutes and their expected environmental impact, and an assessment of possible regulatory options.

Fiber, Fabric Imports, Exports

A study recently completed by the Department of Labor indicates that under the rules governing growth rates in imports, foreign production will account for 50 to 60 percent of total men's apparel sales in the United States in another ten years. This projection is based on the present 6 percent growth each year for imports and a growth of only 3 percent in the total American market. In 1976, 30 percent of men's shirts sold in the U.S. were imports; 30 percent of sport coats were imported; 18 percent of trousers were imported; and 12 percent of men's suits were imported. Employment in this segment of the clothing industry declined by 25 percent from 1964 to 1976, while employment in the nation rose 32 percent.

Japanese exports of man-made fibers and yarns to the U.S. increased 18 percent in 1976. The major increase was in multifilament yarns which increased 44 percent, while imports of staple fibers and spun yarns increased 4 percent. Polyvinyl chloride and acrylic fiber imports were up sharply, reflecting increased markets in the U.S. for flame retardant fibers.

U.S. exports of man-made fibers and manufactured products showed a surplus over imports in 1976, however. This export balance was slightly lower than the 1975 figure and much lower than the 1974 balance. As a result of shifts in the product mix of imports and exports, imports of all man-made products last year accounted for 9.1 percent of U.S. production, and exports accounted for 11.9 percent of domestic output.

Future Fiber Usage

The chairman of Imperial Chemical Industries has stated that synthetic fibers consumption will outpace that of cotton during the next decade, at

which time cotton and synthetics will each hold 45 percent of the world market. He asserted that polyester prices will continue to undercut cotton prices and by even wider margins in the future. Polyester production costs will also fall with prices making production even more profitable. Because of its value, the use of polyester has become widespread in the Western world. Two areas in which polyester has not made a significant impact are upholstery and carpets. Major opportunities lie in these two areas where polyester's properties have so far not matched those offered now by other fibers. Much of the continued growth of polyester will occur in the developing countries. Polyester's share of these markets will increase from 25 percent to 35 percent within the next ten years.

Carrier-Free Dyeable Polyester

Hoechst Fibers has announced that it will introduce a carrierless dyeable polyester fiber to the carpet industry by the end of this year and probably another for the apparel trade later. One of the major processing difficulties associated with polyester is that of dyeing the fiber. Since it does not contain dye reactive sites, the fiber is swelled and the dye transported inside the fiber by a chemical carrier. The process is expensive in terms of energy consumption and chemical additives to the dyebath. A polyester fiber that does not require a carrier would be of significant benefit in helping carpet firms meet EPA regulations and would be a major factor in lowering production costs through fewer chemical additives and lower temperature requirements for the dyebath.

Eastman Chemical Products had a carrierless dyeable polyester fiber for the carpet industry but withdrew it earlier this year because of its

low profit margin. Monsanto Textiles has had a carrierless dyeable polyester for apparel textiles on the market since 1970, but its higher price has deterred textile companies from using it extensively. Recently, Monsanto has been blending this fiber with its SEF modacrylic fiber and offering the product as nonflammable fiber for the sleepwear market.

Generally, a form of technology for carrierless dyeing appears to exist on a widespread basis but the monetary saving resulting in the dyeing process from the use of such fibers does not offset the increased costs of producing the fiber.

Carpet Growth Forecast

A carpet industry group has forecast that carpet face fiber consumption will grow 52 percent world-wide over the next five years to 2.4 billion pounds. This growth will be accompanied by new style trends, shifts in fiber types, coloration systems, backings and other products. A significant feature of this growth will be the competition between various processes for imparting unique coloring patterns to carpets, including such devices for obtaining multicolored effects as space dyeing, TAK, Millitron, and screen printing.

The outlook for the U.S. carpet market in 1977 is optimistic despite the cold weather and fuel supply problems early in the year. It is predicted that a 6 to 8 percent increase in carpet fiber consumption will occur. Several reasons for this encouraging outlook include an improved housing market, particularly in single family and multi-family units; improved business profits and capital expenditure; pent up demand for durable

goods; improved consumer confidence; and a decline in the unemployment rate.

Carpet fiber consumption in the U.S. has been predicted to increase 26 percent over the next five years. This amount is significantly different from the world-wide estimate reported above, but the estimates were generated by two different groups. Nylon, polyester and acrylic are expected to account for 94 percent of the total fiber consumed in carpets by 1981, with nylon remaining the dominant fiber in this market. Acrylic carpets are expected to enjoy excellent acceptance in the contract commercial market. A recent survey indicated that over 70 percent of architectural firms specify acrylic carpets presently, with 35 percent specifying acrylic in blends with nylon.

Fatigue Failure of Fibers in Water

A recent study of fatigue failure of nylon and polyester fibers reported differences in failure rate for these fibers when immersed in water and when dry. The fibers were fatigued by placing them under tension and rotating them over a wire. A fiber is bent at approximately 90^{o} over a wire, is rotationally driven from one end and supports a weight at the other end. As the fiber rotates over the wire, a given surface is subjected to repeated tension and compression which will ultimately result in rupture of the fiber. The number of cycles to rupture was taken as a measure of the life of the fiber.

Results of tests made on dry fibers indicated that fatigue lives of nylon and polyester high-tenacity fibers (used for many industrial applications) were approximately equal. A normal tenacity polypropylene fiber was found to have approximately three times the fatigue life of either of these

fibers. Comparisons of regular tenacity nylon and polyester fiber indicated a fatigue life approximately twice that of polyester for the nylon fiber. When fatigue life was measured with the fibers suspended in water, the fatigue life of the nylon fiber was reduced to a level approximately equal to that of the polyester fiber. Fatigue life of polyester fiber was not affected when immersed in water.

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Developments in Wet Processing

Recent trade shows and other disclosures have given an indication of the rate at which technology is changing in wet processing - cleaning, dyeing, and finishing - of textile fabrics. Cognizant of the rising costs of energy, labor, and materials, manufacturers are developing equipment which utilizes water, chemical additives, energy and time much more efficiently. These equipment developments are spurring the development of new technology relative to wet processing which we feel will have significant application in the technology of subsequent refurbishment processes - washing, dry-cleaning, and drying - of finished textile products.

One of the principal developments in wet processing equipment relates to water volume requirements for cleaning and dyeing. Liquor-to-goods ratios as low as 4:1 are being advertised in equipment, primarily for jet machines, but also for some atmospheric machines. Jet dyeing machines operate on a principle in which a relatively small portion of a fabric is actively treated at a given point in the processing cycle. Such units obviously require long lengths of fabric in the present state of technology since the fabric is fed through a jet tube on a continuous basis. Typically, a single machine contains from one to six jet tubes with most machines capable of handling from 55 to 1500 pounds load capacity. Continuous lengths of fabric are circulated through jet tubes approximately 12 inches in diameter by means of variable speed reels or

other drive mechanisms. Movement through the jet tube is assisted by a stream of process liquor and air. It is only in the jet tube that the fabric is directly immersed with the process liquor, and the effect is more that of the liquor being applied to the fabric instead of the fabric being immersed in the liquor. The intimate and forced association of the fabric and the liquor causes the liquor to be able to accomplish its purpose with the same effectiveness found where the fabric is immersed in large volumes of liquor.

At least one of the jet dyeing units available creates a foam in the dyebath. The foam is said to aid in a number of ways. First, it allows greater surface cover with a smaller volume of water. Second, it provides a cushion effect for sensitive fabrics such as 100 percent acrylic which will develop creases and cracks upon exposure to excessive mechanical agitation and high temperatures. In this machine, the fabric is assisted through the jet by a stream of process liquor and air which is circulated by a centrifugal pump and blower into an overhead venturi and creates the foam in the dyebath.

In a somewhat different approach, a new pad-batch and beam wash-off method for dyeing fabrics of cotton and cotton blends has been developed. The range uses an immersion squeeze system where the fabrics pass through a mangle prior to dyeing. The mangle squeezes the air out of the cloth providing for better and more uniform liquor penetration. Its operation was designed to reduce the amount of water required for rinse-off. About 1½ gallons of water per pound of fabric are said to be needed whereas a jet machine requires much more. In the unit's operation, fabric is guided into a dye pan containing immersion rolls and then into a pad nip that spreads the liquor evenly and aids penetration. Next, the fabric is batched onto a perforated beam, wrapped in plastic to prevent evaporation and placed on an A-frame where it

is rotated slowly for two to four hours to allow the dye to react. When this process is complete, the beam is rinsed on a wash-off stand. In addition to a saving in water since the liquor to goods ratio is 1:1 rather than 8:1 as in jet equipment or 20:1 as in atmospheric becks, fuel costs are about one-third compared to other systems.

In another development, a unique method for agitating fabrics has been reported in a solvent scouring range. The agitation is achieved by a method that sets up continuous impulses in a solvent scouring medium which hit the fabric on both its faces in a rhythmic alternation. This action is accomplished in the scouring bath by means of a special pump with a rotating valve that creates 380 shock waves per minute. These shock waves reportedly cause excellent penetration of liquor into the goods. Tubular as well as open-width goods reportedly can be treated. The pulsar pumps are located in the main cleaning chamber, which is preceded by a precleaning stage consisting of a short liquor trough which is followed by a squeeze roller. After cleaning in the main chamber, the fabric goes through two spray units that supply fresh solvent followed by suction devices. Fabrics then go through section drum drying, cooling and deodorizing treatments before exiting.

All of these developments are, of course, designed to be more efficient in the amount of liquor used to treat the fabric and the amount of energy required for subsequent drying. They make use of greater control over the fabric during processing and the methods by which the liquor and fabric are brought together. These initial processing developments will be further refined and will lead to developments in the composition and use of the various chemical components by detergent, dye, and chemical auxiliary

manufacturers. It would seem that with increased costs of heating water, impending shortages of water, increased costs of treating waste water and increased costs of drying that much of this developing technology will be useful in subsequent refurbishment processes.

Trends in Textured Polyester

The past six to nine months have shown a resurgence in fabrics made from textured polyester after severe price and consumption declines in 1976. Recent data and observations have been published which relate to the projected overall long-term usage for multifilament polyester.

The opinion is advanced that consumers continue to appreciate and take advantage of the benefits inherent in filament polyester fabric. It is expected that the basic consumer business in medium deniers, 70 denier to 150 denier, from which almost all products to date have been made, will strengthen during the next several years. Textured polyester will benefit further by increases of moderate proportion in finer deniers, such as 40 and 50 denier in warp knitting. More substantial gains in the relatively new area of textured coarse yarn deniers, generally 300 to 800 denier, will represent new markets.

There are three general consumption areas for textured polyester yarn. The traditional markets include essentially those apparel markets using 70 to 150 denier polyester. New medium denier markets will continue to focus on the 70 to 150 denier range but will include added emphasis on 40 and 50 denier polyester for tricot. These newer markets will include non-outerwear and end-uses such as underwear, domestics, and home furnishings. New coarse denier markets will be supplied by 300 - 800 denier polyester substituting for spun yarns in end-uses such as apparel outerwear, home furnishings, and industrial fabric applications.

With the decline in textured polyester consumption in 1976, manufacturers launched a determined effort to find new end-use markets. The outcome of these activities has surpassed expectations with some specific inroads of textured polyester in the following areas: as backing yarn for knit pile fabrics; as a replacement for cotton yarns in tickings; as a substitute for filament nylon support yarn in warp knit upholstery; as an experimental replacement for spun yarns in bed sheets using filament filling and spun warp; as a replacement for filament rayon in drapery fabrics; as an experimental substrate fabric for coated fabrics in upholstery; as a replacement for cotton yarns in elastic waistbands and narrow fabrics and straps; and as an experimental 50 percent component in men's underwear.

Economics is one of the most important reasons for textured polyester inroads in these products. For example, carded cotton yarn of equivalent weight per unit length cost $1.38 per pound in mid-summer while textured polyester yarn sold for $0.97 per pound. Using textured polyester in place of fibrous polyester in men's 50/50 polyester/cotton T-shirts on this basis would result in a 16 percent cost advantage for the textured polyester yarn.

In new coarse denier markets, warp face fabrics used for linings, baggings and coated material substrates appear to be likely candidates. Such fabrics have minimal requirements for filling yarns, these generally being economics and good mechanical quality. It is anticipated that textured polyester yarn can serve as filling yarns for many of these fabrics.

On the whole, it is expected that polyester multifilament yarn gains will average 12 percent per year during the next several years because of its advantages in the three marketing factors of economics, aesthetics, and performance.

Future of the U.S. Knitting Industry

Earlier this year, Kurt Salmon Associates began a survey to help construct a profile of what the United States knitting Industry may be like by the end of the 20th century. Using a modified Delphi approach, KSA sent confidential detailed questionnaires to a selected group of executives representing all segments of the knitting industry. Their replies were consolidated to reveal the following points.

The survey concensus held that total knit fabric production will follow a modest upward trend over the next 23 years, avoiding a replay of the disastrous rapid growth/decline cycle that occurred in the early '70's. Total production is expected to increase 36% over 1976 levels by 1985 and to continue this growth to slightly more than 100% increase through 2000. Most of the respondents expect that large, diversified companies will expand their share from 25% to 30% by 1980 but that this share will not increase much beyond this amount.

Despite a declining market in recent years, doubleknits are expected to grow faster than any other segment of the knitting industry through 1990. Volume of doubleknits will increase by 26% over 1976 levels by 1980 and will double to 1,000 million pounds between 1985 - 1990. Most respondents felt that doubleknit production will reach 1500 million pounds, almost 200% above 1976 levels, by 2000. Single knits are expected to growat a lower rate, regaining 1974 levels by 1980 and increasing by 50 percent to 1985 - 1990. Warp knits will increase from a 1976 level of 400 million pounds to 500 million pounds by 1985 and to 1000 million pounds by 2000.

Warp knits are expected to increase their share of the market in lingerie, swimwear, and upholstery. Respondents were divided on whether warp knit or

double knit fabric will have an increased share of men's slacks and suits.

A large percentage of the respondents expect spun yarns in knit fabrics to increase to 55 percent of total yarn consumption by 1985 and then level off. Multifilament yarns are expected to grow more rapidly than spun yarns. A spun-like filament textured polyester yarn is expected to become available in the next few years and occupy a major but not dominant position in the market. The price of multifilament textured yarn is expected to gain on the price of spun yarns but remain below that of spun yarns for a long period of time.

Polyester filament yarn consumption, now at 510 million pounds, is expected to increase to 600 million pounds by 1980 and 1000 million pounds by 1990. The future of nylon filament yarns seems less clear-cut, with half of the respondents expecting no change and half expecting a slight increase in consumption. Little optimism was apparent for growth of rayon-acetate-tri-acetate yarns.

Future problems for the industry that were cited were energy shortages, people problems, governmental regulations, and imports.

When asked to name the three most significant technological breakthroughs expected by the end of the century, respondents cited new fibers and yarns, equipment innovations, and dyeing and finishing improvements. In new fiber and yarn development, the largest single development cited was the development of a spun-like filament yarn. Equipment innovations generally related to needle refinements and new loop-forming systems. Extreme views were presented by several respondents who believe that non-woven formed fabrics and multi-shed (very high speed) looms will partially or totally supplant knitting as we know it today.

On the whole, the respondents are looking ahead with more optimism toward modest but steady growth and a more sensible approach to expansion for the knitting industry, quite different from the roller-coaster ride of the last few years. They also expect some major technological advances and a more stable profit picture by the end of this century. Differences of opinion were expressed regarding how much the consumption of spun yarns, rayon-acetate-triacetate, and nylon filament yarns will grow. In regard to new technology, little agreement could be reached on when or if a new loop-forming system will replace the present latch needle system on circular knitting machines.

DuPont's Spun-Like Filament Yarn

DuPont has announced the development of a spun-like filament polyester yarn, called at the present time TRL-40. This yarn joins two other yarns - Celanese's Lambda and Hoechst's 6-6-0 - in the knitting trade as a possible improvement in polyester yarns, eliminating the plastic look of standard polyester doubleknit. DuPont has taken a slightly different approach from that taken by Monsanto and Hoechst in that the latter produce textured yarns which compete with their customers - yarn texturers. DuPont produces the base yarn only which is subsequently textured by their customers. No information has been released describing the characteristics of the yarn and the principles by which the spun-like effect is obtained. At the present time, DuPont is working with only one texturer who in turn is working with only one knitter. The texturer anticipates that his volume will increase to 12 - 15 million pounds per year by 1980. This yarn costs approximately 50 percent more than the basic polyester textured yarn normally used in doubleknits.

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Causes and Reduction of Soil Buildup on Carpets

The known soiling deposition and retention mechanisms for carpets were reviewed in a recent publication with descriptions of existing soil retardant materials. Soils are classified principally as (1) oily or greasy, nonpolar and insoluble in polar solvents; (2) solid soils which may vary in polarity and charge; and (3) staining agents which may be readily or partially soluble in water. In discussing a "total maintenance system", the author describes soil migration patterns and mechanical soil removal mechanisms and the fiber's role in soiling. Working in this system are chemical anti-soiling agents and mechanisms for soiling resistance which can be imparted by carpet manufacturing processes. A new system which has been developed based on the author's analyses involves application of a fluoro-chemical soil retardant finish in the carpet manufacturing process, cleaning as necessary with a fluorochemical-based shampoo, vacuum extraction cleaning and retreatment with a water-soluble, fluorochemical soil-retardant finish. It is claimed that carpets can be made to stay clean three times longer with a cleaning advantage maintained by the shampooing technique. Data presented on maintenance costs indicate that total maintenance outlay for treated carpets is about one-half that of untreated carpet.

Variations in Fabric Ignition with Ambient Humidity

Most standard tests to evaluate the flammability of a material are concerned with flame or char spreading or with the tendency to self-extinguish. Recently, attempts have been made to measure another important characteristic - the ease with which a fabric ignites when exposed to a flame. Ignition time, however, varies with the moisture content of typical textile materials, which in turn varies with ambient humidity level.

A study of ignition times has been made on a series of fabrics over a range of ambient humidities from 1% to 80% RH. The results show that ignition time increases linearly with increasing RH. For a 124 gram/meter^2 polyester-cotton fabric, the change is small. The slope increases slightly for increases in fabric weight for cellulosic fabrics and increases significantly for wool fabrics. When ignition time is plotted against fabric weight for at 1% RH, a linear relation is obtained for the cellulosics, indicating that it takes approximately one second to ignite a 100 gram/meter^2 fabric (using the specific test apparatus). As RH is increased, the linear dependence on fabric weight becomes greater, reflecting the increase in water content.

Actual amounts of moisture absorbed by the fabric over the range of humidities were measured. Ignition times measured at 80% RH were compared with values predicted by adding to the ignition time at 1% RH the time to vaporize the additional mass of water. The results indicated support for the theory that most of the water contained in a fabric is vaporized prior to ignition. If true, the intrinsic tendency of a material to ignite may be

quantified using ignition time vs. fabric weight data measured at RH close to zero or data extrapolated to zero RH.

New Air-Jet Texturing Units

Basic to the production of the spun-like filament polyester yarns that have so far surfaced is some form of air jet processing combined with false twist texturing. As a texturing technique, air-jet processing is relatively old. However, with its apparent combination with false twist texturing, machinery manufacturers have begun air-jet development programs. This development effort would permit manufacturers in the texturing industry to produce spun-like multifilament yarns from untextured yarns supplied by the fiber industry. It is reported that the two remaining producers of false twist texturing equipment are actively developing machines or modifications with this capability.

The concern among the machine builders is that present demand may not warrant the large capital investments required for conversion to spun-like false twist machinery. As we have reported previously, the demand is expected to increase but still remain relatively small when compared to total textured polyester volume.

Hospital Use of Nonwovens

The formed fabrics industry reported on the results of another questionaire to hospital administrators regarding their use of nonwovens in hospital applications. From the replies, the following points were obtained. Expenditures by hospitals for nonwovens ranged from $1,000 to 700,000 per year. A

large proportion - 98% - indicated that they liked the products they tried. The most used products were face masks, underpads and caps, while the least used were drapes and towels. Asked to identify the most important nonwoven product, 39% identified underpads. Operating room packs and face masks were the next most important products identified. The least-liked factor about non-wovens was identified as price, with storage problems being the other major item. Good features of nonwovens were found to be convenience, cleanliness, labor savings and quality. Improvements desired included lower prices, standardization in size and quality, bacteria-proofness, and self-destructiveness.

Nonwovens Industry Growth

The nonwovens industry will grow by approximately 10 percent per year through 1980 according to a major study recently completed. The U.S. is expected to be the growth leader with projected gains of 15% annually over the next five years. The value of U.S. production in raw stock dollars will be $1.26 billion in 1980, up from $630 million in 1976. This amount will be broken out as $760 million for durable and $500 for disposable end users. End use expenditures will be $500 million for health care; $470 million in industrials; $210 million in household furnishings; and $80 million in apparel. A difference in approaches to nonwovens marketing is also foreseen. Previously, many projected-end use applications have been approached by "positive thinking". Most manufacturers are now looking at the problem of nonwoven marketing through the identification of areas of application and the development of fabrics to supply needs, particularly in industrial problem solving.

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Impending Changes in Wash and Wear Fabrics

Recent actions taken by the Federal Government in beginning studies of processes using certain chemicals on their list of suspected toxic chemicals pose possible significant changes in wash and wear fabrics as we presently know them. Most finishes that are used in these wash and wear finish systems are based on formaldehyde resins. Formaldehyde is one of the chemicals on this list, and processes in which it is used are being scrutinized to determine the danger to people in the workplace as well as dangers imposed by waste products from these systems in effluent discharged by plants. At the present time, there are a number of compounds that are being investigated as substitutes for formaldehyde-based resins. These generally consist of low molecular weight polymers which are applied to fabrics and are subsequently cured by exposure to electron beams or by heating. It is reported that at least one major producer is currently evaluating such products applied to bedsheets. We do not know at the present time if changes will be required in the means by which products treated with these new finishes are washed. We do feel that there is a very high probability that formaldehyde based resins will disappear from usage through the next five years. It is something of which Whirlpool should maintain an awareness because of the possible changes that may be necessary for proper washing.

New Washfast Dyes for Wool

Several projects aimed at providing a sound technological approach to problems commonly encountered in processing wool textile materials have been described recently. The object of one program has been to develop a range of lightfast and washfast dyes for wool. With changing fashions and fabric structures, there has been an increased demand for ranges of colors and shade and stability to light and washing that cannot always be met by available wool dyes. Investigations to date by the Commonwealth Scientific and Industrial Research Organization in Australia has found means of providing good fastness to both light and washing by synthesis of reactive polymethine dyes capable of binding covalently to wool.

Associated with this work are efforts to improve the dimensional stability properties of wool through the use of improved finishes. Because wool has a cuticle composed of flattened overlapping cells on its surface, it possesses a unique property of felting when agitated in detergent solutions. This property is valuable in that density of a fabric can be increased by mechanical means, but the same property leads to felting shrinkage when untreated woolen garments are washed. One method of preventing such shrinkage is to mask the protruding scale edges with a thin coating of polymer. A broad range of thermo setting acrylic copolymers have been synthesized for this purpose. Durability of these polymers is essential since the shrink-resistance properties will deteriorate with wear unless the polymer has good adhesion and abrasion resistance. Investigations have indicated that the most effective treatments are obtained with very high molecular weight polymers with flexible backbones, padded onto the fabric from organic solvents.

(This approach is similar to approaches thought to be under development for replacement of wash and wear finishes mentioned above. A basic difference is that low molecular weight polymers are further polymerized after application to the fabric).

Easy Care Fabric Without Loss of Durability

Ease of care properties are not difficult to confer on cotton fabrics. The problems have always been to impart such properties in a way that adequate wear life is maintained. Resins which have been used traditionally are polymerized (crosslinked) after application to the fabric by certain chemicals that when reacted and dried cause the fabric surface to become brittle and thus lose durability.

A new approach developed by the International Institute of Cotton involves two possible means by which this deficiency can be overcome. The first approach involves the pretreatment of fabrics by swelling agents such as caustic soda or liquid ammonia. Such treatment helps to reduce the internal frictional restraints in fabrics and effectively confers easy-care characteristics before chemical crosslinking is carried out. The second approach involves wash and wear resin application which in the process of heating minimizes migration of excessive chemicals to the surface causing degradation of the surface area. The only feasible way to avoid migration on drying and thus improve distribution of chemicals is to reduce the pickup of finishing liquor from 60 - 70% to around 30 - 35%. Low add-on systems of various types are now emerging commercially (reported in our July report). Developed mainly for economic reasons, these systems can produce several beneficial effects on fabric properties. Because of the more uniform distribution, not only are reduced

amounts of chemicals required but abrasion resistance, fabric handle, and absorbency are improved.

Effects of Abrasion in Laundering on Flame Retardancy

A M.S. thesis recently completed at Georgia Tech investigated the effects of abrasion such as might be encountered in laundering on the flame retardancy of flame retardant treated fabrics. The effects of flame retardant treatments on wear resistance has been studied previously, but the converse - the degree of abrasion occurring in laundering and the subsequent loss of flame retardancy - had not been investigated. The purpose of this study was to investigate these effects. Type of flame retardant finish and abrasion conditions were varied. The effects of wet abrasion and dry abrasion imparted by a specially designed abrasion tester were evaluated. Degrees of abrasion were obtained by varying time of abrasion and pressure on the sample.

A topically applied flame retardant finish, a finish that is thermoset in the fiber, and one that is resin-cured in the fiber were evaluated. These finishes were applied to all-cotton fabric. Abrasion was found to occur in a plucking action in the resin-cured finish, but as a surface cutting action in the thermoset and the topically-applied finishes.

Flammability was found to be reduced by abrasion in the topically applied finish, while no changes occurred in the fiber imbedded finishes. This change was apparent as measured by char lengths resulting from the vertical flame test and LOI values. Generally, dry abrasion showed either no change or slight increases in resistance to flammability for all of the fabric finishes. Wet abrasion showed either no change or a decrease in resistance to flammability.

An increase in flammability resistance can be explained by the depositing of resin and fibers from abrasion in the fabric interstices, while in wet abrasion, this material is being removed.

Levels of abrasion chosen were found to result in somewhat harsher wear than that observed in fabric samples laundered 35 times under controlled conditions and supplied by Whirlpool.

Consumer Reactions to Clothing Quality

A discussion was held at a recent meeting of ASTM Committee D13 on Textiles on consumers and clothing quality. Three speakers representing a retailer, a fiber producer, and a consumer research organization presented their findings on consumer reaction.

In a survey of consumers, the consumer research organization found that consumers are most concerned with and upset by defects such as seam openings and other cut and sew problems. Also important were problems of fit and premature wear of the garment. Most consumers feel that quality of clothing is lower than it has been because of difficulties associated principally with decreased durability. Ease-of-care finishes seem to have contributed little in the consumers' minds toward improvements in quality.

The fiber producer's comments were based on the return of unsatisfactory items under a guaranteed wear life program. Complaints in about half of the women's wear items were related to fit. Many other complaints related to garment construction problems, while very few complaints related to change in appearance or wear in female wearing apparel. In men's wear, premature wear accounts for about 90 percent of the complaints. Undoubtedly, much of the difference between complaint levels for specific items of men's wear and women's wear

relates to psychological perceptions. The speaker did not elaborate further on the meaning of his observations.

The retailer had the opinion that garment quality has not changed drastically over the past ten years. He did feel, however, that the consumers' expectations of quality are lower and that generally consumers expect to find defects such as open seams. If the defect is one that can be repaired, consumers generally do not complain; however, if the defect is associated with fabric imperfections, the consumer will generally complain depending on the severity of the defect. "Performance" of the item is by far the largest factor in consumer complaints.